H. SAMUEL, A.M.Inst.T.

RAILWAY OPERATING PRACTICE

Operating Principles: Track and Signalling: Freight and Coaching Stock: Motive Power: Stations, Terminals, Marshalling Yards: Plan of Operation: Control Office: Services and Transits: Punctuality: Statistics

FOREWORD by A. R. DUNBAR, O.B.E.

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BY

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FOREWORD

By A. R. DUNBAR, O.B.E.
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IT IS usual now to combine in a railway traffic organization the formerly separate departments of Commercial, Operating and Motive Power. This change has brought together the policy-making and executive leadership of these functions. It serves amongst other things to emphasize the net revenue objective, bringing together the responsibility for both traffic receipts and working expenses. In striving to get these elements in proper balance in this way the essential functions of railway operating, its cost and its efficiency, are in no degree diminished in importance. Operating techniques are still and must always be at the core of the railway business.

A modern textbook on railway operating has for long been needed and I am glad Mr. Samuel has written this comprehensive and stimulating book on the subject. Like most of his illustrious predecessors in this field, he is a product of the traffic apprenticeship system. This training has had a strong influence on operating thought through the years, especially in the direction of planning for maximum utilization, and this theme quite properly dominates the author's approach.

The full use of men and equipment is also a first requirement in present-day railway modernization. It is essential for economic success. It can be produced by good planning and efficient execution. Good planning means pre-arranging the economic use of all operating men and equipment, and setting it out in publications for all to see. Efficient execution requires supervision of the plan and control of the unplanned units, and of those which for one reason or another depart from time-table roster or diagram.

The author has sought to present sound reasoning and commonsense advice on the best ways to follow this through. Operating is not an exact science. There is room for plenty of judgment, for different views on the proper solutions, and for opinions on the relative importance of its various components. It is hoped that this book will stimulate thought and controversy on some of the topics, and the author's conclusions on them.

London, 1961

PREFACE

THE main development in transport in recent years has been the growth of private transport. There has been a substantial increase in cars and motor cycles and at the same time a growing tendency for traders to carry their freight in their own vehicles. This has intensified the competition between the professional hauliers for the traffic that remains. It has become necessary for them to demonstrate that the services they provide are so cheap, so fast and so reliable that there is advantage to the private vehicle owner in using them. The more competitive conditions have been accompanied by striking technical advances in all forms of transport. Progress has, perhaps, been most marked in air transport, and in consequence the air-lines have tended to increase their share of the available traffic.

All this has had serious repercussions on the finances of the railways. It has become clear that the quality of the service offered by the railway must be transformed into something far superior, while at the same time the cost of producing the service must be reduced. Technical developments can help in achieving this, but the knowledge, skill and enthusiasm of the railwaymen is of even greater importance. This book is designed to help the less experienced railwaymen and students of railway operating to increase their knowledge, thereby assisting them to play their part in the vital work which has to be tackled.

As railway operating is not yet an exact science, there may be several different solutions to some operating problems. I have tried to set out the advantages and disadvantages of adopting different courses of action to enable the reader to reach his own conclusions. Where a preference is stated for a particular method this is my own opinion and does not necessarily represent the policy of British Railways.

My main theme is the identity of interest between the customer and the operator, and I have tried to show that the provision of the type of service which the customer demands—in particular one that is fast and reliable—is often the best means of reducing long-term operating costs.

In the preparation of this book many people have given me invaluable assistance. In particular I wish to mention Messrs. J. H. Hubble and T. E. Howgate, and my wife Dorothy. I also acknowledge the kind permission of the following to use copyright photographs supplied by them: E.M.I. Electronics Ltd., the Pressed Steel Company Ltd., the Westinghouse Brake & Signal Co. Ltd., and British Railways.

Derby, 1961 H. S.

CHAPTER 1

Principles of Railway Operation

THE newcomer to the field of railway operation might be excused for believing that decisions were based on some mysterious intuitive powers given to those in authority. Most successful railway operators have been brought up in the empirical school. They are apt to attribute their achievements to personal qualities rather than to working to principles. In addition, they are often under such pressure resolving problems that arise and so immersed in details, that they are unable to find time to analyse their own actions. They fail to reflect on the criteria which they apply, possibly subconsciously, to the issues with which they are faced. Some might even believe in their own intuition.

But principles do exist, and it is vital to define them at the outset and to study their application in particular fields in subsequent chapters. They are simple. They are largely common sense. Some readers may think they are so obvious that it is not necessary to define them. However, when faced with a complex problem, one's confidence is enhanced when there are simple principles to apply. It does not always make the correct answer easy to find. A principle is not a rule to be followed slavishly, it is merely a fundamental truth, a basis upon which one can reason. There is no satisfactory substitute for clear thinking built upon experience, but the guidance of sound principles can be valuable. Let us consider what these principles are.

1. *Keep traffic and mobile equipment moving.*

The transport operator is paid for moving traffic, i.e., persons or goods, from one place to another. This is usually performed in the carrier's vehicles. The carrier does not get paid, as a carrier, for the time that the traffic is in his care but not moving. This standing time has many disadvantages to the operator, for example:

(*a*) The extension of the journey time or transit is a potential source of irritation to the customer and could lead to transfer of the traffic to another form of transport.

(*b*) The responsibility of the carrier for the safety and security of the goods or the passenger continues during the standing time.

(*c*) Provision has to be made for accommodation of the traffic during this time. This accommodation may be, for instance, a wagon.

Standing time occurs when a wagon is loaded, but is not forwarded immediately; when the train conveying the wagon enters a marshalling yard; or if it is not unloaded immediately on arrival at destination. In each case the traffic is being contained in a wagon, which was built for moving traffic, not for holding and protecting it at a fixed spot.

In some cases the railway actually incurs expense in order to provide a facility which would not be needed, if we could avoid this standing time. One example is a goods tranship shed. You may be able to think of many others. The payment the carrier receives, therefore, is for moving traffic. The peril and costs continue and even increase in certain directions when movement ceases.

Just as it is important to keep the traders' traffic moving, it is equally important to keep mobile equipment working at its legitimate function, i.e., moving under load as continuously as possible. A feature in recent years has been the increased cost of equipment, largely due to its increasing complexity. But the principle does not depend on relative values. Inexpensive equipment should also be kept employed to the maximum. The higher cost of equipment has merely increased the penalty imposed, when it is not exploited as it should be. Much of the mobile equipment of a railway is staffed; e.g., rolling stock and locomotives by train crews, road vehicles by drivers. If the equipment is kept moving greater productivity of these employees follows in its wake. In the chapters that follow, the advantages that accrue by adherence to this principle will be demonstrated many times. One simple illustration only will be given at this stage.

EXAMPLE. *A* and *B* are medium-sized towns 20 miles apart with a fair interchange of passengers. There are several intermediate village stations, but the use of the trains at these points is small. They are served by two diesel rail car trains, which leave *A* and *B* each hour, on the hour, from 7.0 a.m. to 9.0 p.m. The service is supplemented in the morning and evening busy periods by other trains, but the details of these need not concern us. The over-all journey time, with all intermediate stops, is 40 minutes, i.e., an average speed of 30 m.p.h. including stops. Thus from 7.0 a.m. to 9.0 p.m. (15 trips) each unit works 15×20 miles $= 300$ miles per day.

By omitting the intermediate stops, the time needed per trip may be reduced from 40 minutes to 24 minutes (i.e., an average speed of 50 m.p.h.). This has the immediate effect of enabling the work to be performed by one train instead of two. Two trips can be performed in an hour with a six-minute turn-round at each end. Reduction in train crews would not necessarily be 50 per cent, as with the units, owing to the need for meal breaks and on account of restricting agreements with the trade unions on manning in relation to mileage per shift and other factors. However, the staff savings would be of value. There are a number of consequences which would need to be considered:

(1) The question of providing some service for the intermediate stations,

if justified on economic grounds. This might be done by restricting the service to the peak-hour trains or by using the standing time of units on other lines towards providing a stopping service. The over-all effect might be a small reduction in passenger revenue at the intermediate points owing to the reduction in service. The chances are that this would be offset by:

(2) A substantial increase in the use of the services between *A* and *B* by virtue of a reduction in the journey time from 40 to 24 minutes. The advantage of rail against road travel would swing more in favour of rail traffic.

(3) The service would need to leave either *A* or *B* on the half-hour instead of on the hour.

In order to maintain movement, it is implied that congestion must be avoided. Congestion is one of the deadliest enemies of efficient operation, because its effect tends to spread outwards from the trouble spot and the paralysis which follows extends ever wider unless firm steps are taken to find a remedy. Quite clearly, congestion would not arise in the first place if the operator were able to keep up the movement. There are times, however, when the temporary cessation of movement is inevitable. Trains must stop at certain stations for traffic purposes. Wagons must come to rest in a marshalling yard or a goods depot. In consequence, it is not surprising that it is in the environs of stations, yards and depots where congestion is most likely to arise. Once this happens there is an immediate danger that the congestion at these spots will lead to an inability to accept traffic currently. This tends to bring trains on the running lines approaching the depots to a stand, and the paralysis begins to spread. One of the main functions of the Control organization is to avoid congestion. How this is done is described later. But a responsibility rests with every member of the staff to help to avoid congestion by adherence to the principle of maintaining movement.

2. *Speed is economical to the operator.*

In the example quoted under principle No. 1 the cheaper service was provided by keeping the diesel trains moving instead of stopping at the intermediate stations. The result was that an average speed of 30 m.p.h. was raised to one of 50 m.p.h. and this illustrates very well the second principle—that speed is economical. If the increase in average speed could have been achieved by faster running between stations, rather than by eliminating calls, the benefits would have been as great, and the resultant problems less. An example of the effects of acceleration of freight trains will demonstrate further the advantage of fast speeds.

EXAMPLE. From yard *X* to yard *Z* is 120 miles. Between them there is a regular flow of traffic which passes at 20 m.p.h. After the train crew signs on duty at *X* about an hour of their shift has elapsed before their train departs, owing to preparatory duties at *X*. By the time the train reaches *Y*, half-way

between *X* and *Z*, they have been on duty four hours (1 hour+3 hours at 20 m.p.h.) and it is necessary for them to be transferred to work a train travelling back towards *X* in order that they may reach their home station within the duration of a working day. Another train crew sign on at *Y* to work the *Z*-bound train, and later to work a train back from *Z* to *Y*.

If train speeds are increased to 40 m.p.h. the train crews from *X* are able to work through to *Z* and bring another train back within the compass of a daily shift, and no crews will be required at *Y* at all. Indeed, trains should no longer need to stop at *Y* and thus it is possible to keep moving. Locomotives will be able to make more journeys on account of the reduced journey time, and the number employed may be reduced. Faster journey times may reduce the number of wagons required. Also the faster speeds make more economical use of the track (see Chapter 2, page 35).

It is necessary to mention the main complicating factors in employing this principle:

(1) If faster speeds can be achieved only by conveying smaller loads, additional trains may be required. The cost and effects of the additional trains must be taken into account. These considerations are discussed in Chapter 11 so far as freight train services are concerned, and in Chapter 13 in connection with passenger train services.

(2) Increases in speed must be on a broad basis, and are most beneficial when applied to the slower-moving trains. To accelerate individual trains to speeds in excess of other trains over the same route, will permit more work to be obtained from the locomotive, vehicles and crew of that train, but may so interfere with the running of other trains that the net result may be a loss in productivity.

(3) If very high speeds involve an increase in braking distances (see Chapter 2) it may be necessary to space trains more widely apart, thereby reducing the capacity of the track.

Customers frequently require fast transport. The operator's costs usually decrease as the time taken to perform transport is reduced. Therefore, speed is in the common interest of the customer and the operator. It is necessary to emphasize this *to the operator* as the engineer's considerations are different. The power required to move a given load at an increased speed is not directly proportional to that increase but to the square of it. When ordering new equipment this must be taken into consideration, but the speed potential of existing equipment should be exploited as far as possible, consistent with reliable performance.

3. *Operating units are interdependent and their reaction on each other must always be considered.*

A unit is any component of equipment or staff available to the operator. The term includes the track as well as wagons, marshalling

yards and drivers; in fact, every item of equipment, mobile or fixed, and all operating staff.

It has just been mentioned that the introduction of one train at a higher speed might adversely affect others working over the same track. Similar examples of interdependence can be found in every branch of railway operation. To some measure it is a consequence of the railway's inherent disadvantage of being track-bound. One immediately thinks of the late-running train, which reacts on (1) following trains on the same track, (2) immediately preceding trains of less importance on the same track, which are shunted clear on its behalf, (3) connecting trains at junctions, (4) trains with which it conflicts at junctions, when the late-running train is given priority over them. The effect of (3) and (4) spreads the delay from the original line on to other lines, and the ultimate reaction may be felt hundreds of miles away.

The interdependence of operating facilities needs to be considered carefully when new facilities are being provided. For example, in taking steps to eliminate a bottleneck on the track by, say, the provision of additional running lines, it is important to ascertain that the remainder of the line concerned is capable of dealing with the increased through-put which is envisaged. If it is not, the only achievement is to transfer the bottleneck from one point to another. Similarly, if a new marshalling yard is being planned, the effect of the intensified train service on the lines in the vicinity must be considered.

One of the vital considerations is the reaction of passenger services on freight. An organization of railway administration, which divides passenger work from freight at various levels, has to ensure that the correct balance between the two is created and maintained. There is a temptation to give undue priority to the passenger services which are more in the public eye. Yet it may often be the freight services which are more profitable, and it is folly to prejudice the carryings of potential money-making traffic for less lucrative work.

The best organization is one which devolves responsibility for both passenger and freight traffic as widely as possible. When a split must be made between the two, thorough co-ordination of them is important.

4. *The advantage of rail transport over road transport can best be exploited over long distances with capacity loads.*

Perhaps the best way to reach this conclusion is to consider first the disadvantages of rail transport as compared with road transport. We are brought back again to the main handicap of the railways, i.e., being track-bound. You will recall the old music hall joke:

Passenger: Why did they build the station so far away from the village?

Porter: So that it was near the railway, Sir.

The problems are, first the distance between the customer's premises and the railhead and secondly the transfer between road and rail vehicles at the railhead. They are problems of time and expense. Their relationship to the total journey time and to total journey cost, decreases as the length of the rail haul increases. If your house is 15 minutes distance from the station, on a 15-minute rail journey, travelling to the railhead doubles the journey time. In addition there would be a journey from the destination station to the ultimate destination, to extend the over-all journey time still further. In this case, it is quite likely the trip could be accomplished more quickly and conveniently by private car and possibly by bus. On the other hand, if the rail journey is of several hundred miles and took, say, five hours instead of 15 minutes, the ratio of time taken in getting to and from the railhead in relation to the over-all journey would be quite small. The faster time of the rail journey, as compared with the time it would take by road, should more than compensate for this.

So much for the time factor. Now let us briefly consider the question of the expense of transfer between road and rail. With passenger traffic the expense is the cost of the passenger station, the staff employed there and the cost of stopping the train at that station. With freight traffic there are additional costs involved because, unlike the passenger, the freight cannot transfer itself from road vehicle to rail vehicle. Staff and equipment are necessary to do this work. The cost varies according to the nature of the traffic and other factors, but it can be formidable. These terminal costs in relation to the total movements costs decrease as the length of journey increases. The ratio of cartage costs, i.e., road transport costs between the customer's premises and railhead, to total costs vary similarly for the same reason. It can be seen, therefore, that the longer the distance the greater the advantage of rail over road. Conversely, over short distances transport by road may be faster and cheaper.

But why capacity loads over long distances? Again, it is advisable to consider the disadvantage of rail. In this case, the disadvantage is the absolute block system of signalling. This is explained in detail in Chapter 2. Briefly, it is a method of dividing a railway line into sections and then permitting only one train to be in one section at a time. It is the method which enables such a splendid safety record to be maintained. It permits trains to run safely at high speeds. However, it has this disadvantage as compared with road transport—only one train is

permitted in one block section at a time. The block section may be a mile long. It may be several miles long. On a section of highway of similar length hundreds of road vehicles could keep moving at good speeds. In consequence, if only one train is permitted to be in a block section, it must convey a large load. Ideally, this should be the maximum load which the motive power is capable of hauling at the speed at which the train is required to run. As the ratio of tare weight to pay load weight is quite high enough even when the vehicles convey maximum pay loads, it is important to ensure that void space (e.g., empty seats on passenger trains, spare capacity in freight vehicles) should be kept down. Always remember, too, that train-crew costs and the time which the block section is occupied do not vary with the load of the train. The wages of the driver and guard remain the same whether their train conveys 20 or 50 wagons, and the waste of the potential of the locomotive hauling the smaller load is by no means offset by the comparatively small saving in fuel.

Earlier, it was said that these principles are not easy to apply, and one must be particularly careful in aiming for capacity loads. Although they are highly desirable for the reasons mentioned, there is great danger in obtaining capacity loads at the expense of the quality of the service offered to the customer. It is possible to obtain full wagons by detaining them until sufficient traffic has been assembled to fill them. Similarly, full train loads can be obtained by holding the wagons on hand until a load equal to the capacity of the locomotive has accumulated. Both these courses of action are likely to result in extended transits to traffic, and the detention, in any case, is in contravention of the first principle of operation. It will be seen in subsequent chapters that often the operator must be satisfied to run his service with comparatively small loads in order to provide a satisfactory service.

5. *The potential capacity of operating units is not fixed, but is dependent on the method of using them.*

It may be known that a particular wagon has a capacity of 20 tons. This signifies its maximum loading at a particular time, but how much work the wagon is capable of doing depends on the way it is used. To go back to the first principle: Is it kept moving? It may do one loaded trip a day or only one in ten days. If it is moved about quickly (our second principle) it will have a greater potential for doing more work. It can do twice as much work if it is carrying its limit of 20 tons as compared with a regular loading of only 10 tons. And so it is with all equipment and staff. A locomotive may be usefully employed for only 15 hours or for 20 hours, its driver for only five hours in his shift, or for

the full operation of it. The term employed to describe the useful work extracted from a piece of equipment is *utilization*. Because there is no fixed capacity of men and machines over a period of time, the degree of utilization attained regulates how many one needs to employ to perform a given amount of work. This affects the size of the wages bill. On utilization also depends the quantity of capital it is required to invest in operating equipment, the amount of interest payments and depreciation charges. In addition, it regulates the amount of maintenance to be done and the wages to be paid. The lesson to be learned from this is that, before demanding additional staff or equipment, one should determine the optimum performance or capacity of the existing operating units and attempt to achieve it. This may avoid incurring additional cost. Similarly, in planning new schemes, the existing performance, which may be well below the optimum, is not a satisfactory measure in assessing what may be required.

Utilization ultimately decides the ability of the railway operator to compete with other forms of transport at economic levels. Try to think of how one might increase the capacity of a marshalling yard, a block section or a goods depot, without altering them physically but by revised working methods.

6. *The retention of operating units in excess of needs involves unnecessary cost and leads to inefficient working.*

Certain equipment is provided by other railway departments for use by the operating department. In such cases there is a temptation to forget the cost of providing and maintaining it. A short siding in a goods depot, which it may be possible to dispense with because it is seldom used, may not appear—to the operating staff—to cost anything, but we may be certain that it does. It costs space which might be better employed. The points (or switches) which provide access to it have to be maintained. The switch and the siding itself will require renewal at some time. To retain unnecessary units, therefore, is to incur unnecessary costs. This is unsatisfactory, but it is often a minor evil compared with the inefficient practices which are encouraged by the retention of redundant facilities. Too many sidings in a depot or a marshalling yard enable wagons to be kept standing instead of being kept moving. Adherence to our first principle, keep traffic moving, is achieved more easily where there is a healthy demand for the siding space available. Where there is a shortage of space, the operator is obliged to speed up the movement of wagons through the sidings. In doing so he is therefore illustrating the previous principle. Too many passenger coaches and/or too many platforms at a passenger station

will tend to lead to poor utilization of coaches. A shortage of either of these units will act as a spur to improved carriage working. It would be foolish to advocate a shortage of equipment, space or staff, to such a degree that the efficiency is impaired, but it may often be that the perils of excess units are greater than an apparent shortage. By sound operation the apparent shortage can be turned into a sufficiency. Please see Principle No. 10.

7. *Peak demands militate against the full use of equipment or of staff and may lead to uneconomic results.*

If it is agreed that equipment or staff in excess of needs has economic perils, it will be appreciated that peak demands present special problems. Some peaks arise at particular times of the day; e.g., with commuter travel and some at particular times of the year; e.g., with holiday travel. The demands of these peaks tend to regulate the amount or size of the units employed, and there is obviously insufficient work at the off-peak times to maintain full employment of them. It is difficult for many of the people who travel to and from work in crowded trains to understand why the railways do not make a handsome profit from commuter travel. Indeed, some believe that the transport operators should provide more trains at peak times to eliminate the overcrowding. If we consider that some trains make only two trips a day, one in the morning peak and one in the evening and stand idle for over 20 hours out of the 24, the profitability of the service becomes open to question. If it is considered that some drivers and guards make only one trip a day (the duration of their working day cannot be spread over the two peaks) on account of peak travel, considerable doubts arise. Outside the peak periods far more empty seats than full ones are conveyed, and signalling equipment, track, etc., are under-employed.

Peak holiday traffic brings similar problems. Less than half the coaching rolling stock fleet is in a booked daily service throughout the year. It is only on relatively few days in the year that work can be found for the whole fleet. Time costs, i.e., depreciation and maintenance costs, are a big factor with passenger coaches. Let us take one example.

EXAMPLE. Let the annual time cost per vehicle be £X. For a train of ten vehicles therefore the cost would be £10X. If one such train is in booked working for two trips a day say 300 days a year, the time cost per trip is £10X÷600. If the train worked only on six Saturdays in the summer in a year and only made one trip on each occasion, the time costs would be £10X÷6 per trip. In the latter instance the time costs for the vehicles are 100 times greater than in the former, and must seriously prejudice the profitability of the train.

This is not solely a passenger traffic problem. Freight traffic also has its peaks and its valleys. Agricultural products naturally are seasonal in nature. The peak demand for bulk grain wagons operates for a few weeks around harvest time, and the transport operator must endeavour to find other traffic to use the surplus vehicles for the remainder of the year. If he fails, the time cost to be applied per trip employed becomes prohibitive. It is not only in agriculture where there are seasonal demands. Coal mining, for example, reaches a peak production usually in the mid-winter period, when demand is good. This coincides with a demand for mineral wagons for sugar beet, which is also in season at this time. In the chapter on freight rolling stock, some possible methods of dealing with this situation are discussed. At this stage it will suffice if the effect of peak demands are noted and some thought is given by the reader regarding the extent to which the operator should build up his equipment to meet the peaks. Consider also, steps which might be taken to spread the peaks.

This principle, like all the others, must be related to those which precede and follow it. In particular, principle No. 5, which stated that capacity of the units of operation is not fixed but is dependent on the method of using them, becomes of exceptional importance. It is vital to exploit the equipment and staff most efficiently at the time of the peak demand. Subsequently, it will be shown how this may be achieved to a greater degree.

8. *Realistic planning ahead gives the best results, but current modification is often necessary to meet the situation.*

One of the main differences between road and rail transport is the more highly disciplined movement of the latter. This is enforced by the block system of signalling. As explained previously, the method is to restrict the occupation of a fixed section of line (i.e., a block section) to one train at one time. In busy areas there is a danger of many trains being brought to a standstill at the entrance to block sections because they are occupied by previous trains. If this is to be avoided, the maximum number of movements must be planned in advance at such intervals that continuous movement is achieved. This is one of the purposes of the Working Timetable. On the basis of this, planning of the workings of many of the units of operation can proceed. The engine workings, the train crew workings, coaching stock and diesel car workings can be compiled. Prearranged workings, because they are scientifically worked out, plan for the most productive use of staff and equipment. At passenger stations platform arrangements can be decided upon with a view to avoiding conflicting movements and to

facilitate the making of connections. Similarly at marshalling yards a connectional pattern can be established.

There is no doubt that planning pays, but there are times when the best laid plans can no longer operate. For example, if a derailment or collision blocks one or more running lines, emergency arrangements have to be made. Likewise, if traffic fluctuates, plans may have to be adjusted to strengthen the service in a particular direction, and there may be scope for cancellations or combinations of trains in another direction where traffic is below normal. It is the necessity for current modifications to be made to the prearranged plan that is the purpose of the Control organization.

9. *Reliability is vital.*

If careful planning is necessary for efficient operation, it follows that adherence to the plans to the maximum degree is equally important. The formidable expense of the planning can be justified only if determined efforts are made to stick to the plan. One of the aims is to make intensive use of equipment. This necessitates the time between journeys—known as turn-round time—being kept to a minimum. If turn-round time is small, late running on a journey may result in a late start to the next journey. If there follows a series of tightly scheduled turn-round times, the delays may react for a considerable time within the working of the unit concerned. In consequence of the interdependence of operating units, which was the subject of Principle No. 3, the failure of this particular unit to adhere to its schedule may react on the timekeeping of other trains. The cumulative effects could be serious. The consequences are: bad service to the customer and increased costs of operation to the operator; e.g., if train crews do not arrive at their final destination punctually, overtime payments may have to be made. In order to minimize the spreading effect of delays, additional vehicles and men may have to be introduced into the working, with all the additional expense and waste which this involves.

If reliability is vital to the operator it is imperative to the customer. The more frequently a passenger travels by train the more infuriating are delays, so that it is the best customer the unreliability tends to drive away. With freight traffic it is a similar story. One of the main factors which has caused the transfer of traffic from rail to road has been the unreliability of transits, i.e., the time taken to get goods from the sender to the consignee. If one considers consignments weighing several tons, the more reliable service by road than by rail is not altogether surprising. By road, from leaving the consignor's premises to the arrival at the consignee's premises, the consignment may well be

in the charge of one man (the lorry driver). Over short and medium distances the first principle—" keep moving "—may be fulfilled, apart from momentary stops at traffic lights, and a brief stop for the driver's meal or for fuel. By rail, the same consignment would be in charge of the initial driver only as far as the railhead. After it has been loaded into a wagon the responsibility for it passes to many persons—shunters and handling staff at sending and receiving goods depots, probably shunters in the marshalling yard and a guard in charge of the train (or trains) which conveys it. These persons are also dealing with many other wagons and the consignment is not receiving the individual care and attention which the sole driver is able to give during road conveyance. The problem of how to provide a more reliable service will be discussed in later chapters and methods of improving present working arrangements will be proposed.

Reliability of services can only be achieved by sound and careful planning, and then by adherence to the plan. The need to avoid accidents is implied, as railway services are particularly susceptible to dislocation following accidents; this is yet another penalty of being track-bound.

10. *Improved operating methods may result in operating units becoming redundant.*

The sixth principle was that operating units in excess of needs involve unnecessary cost and lead to inefficient working. Conversely, if operating methods are improved, units may become surplus to requirements. You will recall the example quoted earlier in which one diesel railcar was able to perform twice as much work by keeping moving for a greater proportion of the day. In consequence, another train became redundant together with some staff. Similarly in most cases where better methods are introduced, some units may be dispensed with. When marshalling yards are considered, it will be shown that by analysing the traffic passing through a certain yard, it is sometimes possible to arrange for all the wagons to be conveyed by trains which by-pass the yard. This not only improves the transit of most of the wagons concerned but also permits the yard to be closed. When transits are improved, or the loading and unloading processes are speeded up, or better loading per wagon is achieved, a similar amount of work can be done with a reduced fleet of wagons.

Remember what was said in Principle No. 6. Once the improved operation has made the wagons (or any other units) surplus to requirements, ensure that they are withdrawn. Otherwise the presence of a surplus will provide a temptation to work below peak efficiency level.

SUMMARY

The foregoing are the main principles commended to the prospective railway operator. Adherence to them can bring substantial improvements in service and enable much work to be done more cheaply. Here they are again in abbreviated form:

1. *Keep it moving.*
2. *Move it quickly—It's cheaper that way.*
3. *Remember the interdependence of different parts of a railway.*
4. *Longer the distance—larger the load—the better.*
5. *It has no fixed capacity—It depends how you use it.*
6. *If you don't need it—Get rid of it.*
7. *Beware of the peaks.*
8. *Planning pays.*
9. *Be reliable.*
10. *Improve your methods and reduce your costs.*

All these principles are simple common-sense. Alas, one can still find examples of failure to regard them.

CHAPTER 2

Track and Signalling

THE operator of road vehicles makes no direct contribution to the cost of the track he uses. He pays various taxes, of course, which may more than cover the expenditure on roads, but this is a contribution to general taxes and is not directly related to the amount spent on roads or the degree to which he uses them. Therefore, he can clamour for more and better tracks which, if provided, should help him to cut his operating costs and possibly to improve the standard of the service he supplies.

Not so the railway authority, who must buy land, and build and maintain the track, the earthworks, bridges, tunnels, etc., which they require to use. About one fifth of railway costs are absorbed already on track and signalling, and the aim must be to reduce this amount. Therefore, the object is to run the required train service with the minimum land, the fewest tracks and at the lowest total cost for track and signalling facilities. Where traffic is light it has to bear an undue proportion of track and signalling costs and tends to become an uneconomic proposition. Frequent re-appraisals should be made to see if traffic from lightly used lines can be diverted to other routes or be carried by road to permit the line to be closed.

TRACK LAYOUT

Single lines require the least land. In order that trains travelling in opposite directions may cross each other, crossing loops consisting of two lines must be provided at intervals. Where these are used, one train must come to a stand and wait for the other to clear the single line. This conflicts with the first principle of operation and therefore single lines are only suitable where traffic is light. Bearing in mind that light traffic has to bear heavy track and signalling costs, it is frequently difficult to operate these lines economically.

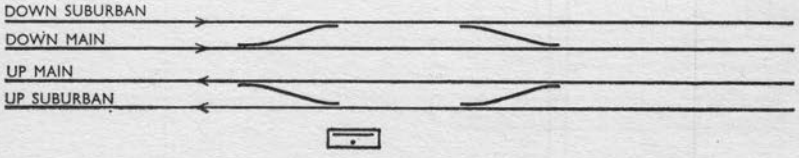


FIG. 1.

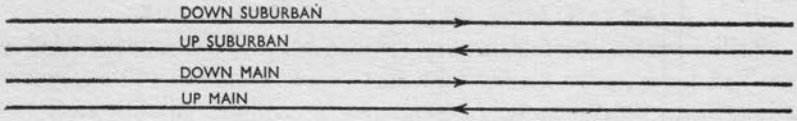


FIG. 2.

Double lines. Most of the railway track in Great Britain consists of double lines. Each line is normally reserved for trains travelling in one direction. This imposes a certain rigidity which may result in one track being under-employed at a time when there are more trains offering than the other line can cope with currently. This can be overcome by banalisation which will be referred to in a later paragraph.

Multiple lines. Where two tracks are inadequate to deal with the traffic, another line, or lines, may be provided in addition to the main (or fast) lines, for the use of traffic in either or both directions. Sometimes the additional lines may be confined to freight trains only, but to give maximum flexibility this should be avoided if possible. They are given titles for identification purposes, suburban lines, slow lines, etc., but are normally available for use by any trains. Where two tracks are provided for trains in one direction, they should be side by side so that movements between them may be made without affecting traffic in the opposite direction (Fig. 1). The best layout in the environs of terminals may be a different one, as a train arriving on the Up Suburban is likely to form a departure on the Down Suburban, and therefore it is desirable that these lines should be adjacent. Similarly, conflictions will be reduced if the Up and Down main lines are adjacent (Fig. 2). Therefore, it is desirable to convert the arrangements close to the terminal, as shown in Fig. 3, by a fly-over, or alternatively by a burrowing-under process.

Junctions. Flat junctions involve confliction of train movements and it is approaching these places that delay is likely to occur. Therefore, it is desirable that they should be arranged with fly-overs or burrowing lines to avoid conflictions. Naturally the cost of flat junctions is less than the fly-over or burrowing lines, but on busy lines the cost of delays may exceed the difference in expense of the two layouts.

FIG. 3.

ADVANTAGES OF A SPECIALIZED TRACK

Rails were first used to convey vehicles because the reduced friction enabled loads to be hauled with less power. This is still the prime advantage. Steel wheels, running over a straight, smooth steel rail enable motive power to be employed most effectively. Another advantage is that the trains have the exclusive use of the track and, therefore, may run with safety at high speeds. A simple comparison is the best way to illustrate the advantage of a specialized track.

In order that the work performed in transport can be conveniently expressed, the term *ton mile* has been devised. One ton mile is the carrying of one ton for one mile; 20 ton miles could be the carrying of 20 tons for one mile, of one ton for 20 miles; or of four tons for five miles, and so on. If a locomotive hauls 1,000 tons at 50 miles per hour this represents 50,000 ton miles in one hour. In a single day, therefore, the locomotive, properly exploited, could have to its credit one million ton miles. Contrast this with a diesel lorry carrying 20 tons of traffic at 30 miles per hour, giving 600 ton miles per hour, which is only 14,400 ton miles per day.

DISADVANTAGES OF A SPECIALIZED TRACK

Some of the railway's handicaps which stem from being confined to its specialized track have been mentioned in Chapter 1. There are two others worthy of mention.

(A) *Effect of Obstructions.* An obstruction of the railway track—e.g., a train whose engine has failed, and is temporarily immovable—can lead to a serious disruption of services. In these circumstances the operator has the following alternatives:

(1) To divert trains by alternative routes. This may involve the trains concerned in a considerably extended mileage and may dislocate the scheduled services over the route used.

(2) On double track, attempts may be made to run trains in both directions over the line which remains unobstructed. Unless the line concerned is laid out and signalled for two-directional working, this is a slow and tedious business, owing to the precautions necessary to avoid head-on collisions and the slow transfer of trains from the obstructed line to the other.

(3) To cancel or postpone movements over the obstructed line until it has been cleared.

Whichever course is adopted, the likely consequence is late arrivals of passengers and freight. Contrast this with the by-passing procedure which can take place when a lorry breaks down on the highway. The interference with the traffic flow in this case is often negligible.

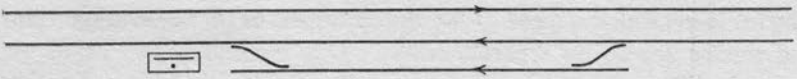


FIG. 4.

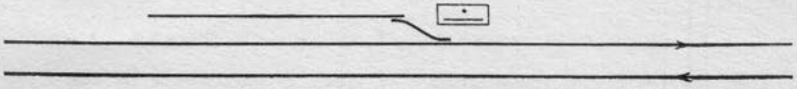


FIG. 5.

(B) *The Overtaking Problem.* Likewise on the roads, it is a relatively simple matter for a vehicle to overtake a slower-moving vehicle, except where the road curves or is narrow. On railways, overtaking can be achieved only by one of the following methods, all of which are expensive:

(1) The provision of more than one track, between certain signal-boxes, for trains travelling in the same direction. The duplication or triplication of tracks for this purpose can be justified only where traffic is heavy. The acquisition of the land, the construction and maintenance of the additional track and signalling would otherwise impose unreasonable financial burdens.

(2) The provision of running loops or refuge sidings. A running loop is an additional running line where the inlet and outlet are controlled from one signal-box (Fig. 4). It is desirable that the loop should be sufficiently long for the slower train to be kept on the move during the time it is being by passed and until it is permissible for it to leave the outlet of the loop. Unfortunately this is often not the case and it is necessary for trains to be brought to a stand with varying losses of time.

Refuge sidings are single-ended sidings normally entered through a trailing connection (Fig. 5). This involves the train which is to be by-passed being brought to a stand and reversed into the siding, where it must stand again until it may re-occupy the main line.

(3) By the use of tracks for traffic in both directions (see Banalisation). Overtaking by this means would be subject to there being suitable gaps in the train services in the opposite direction.

To sum up, one can say that whether overtaking is accomplished by using additional running lines, running loops, refuge sidings, or banalisation, it is always expensive in provision and maintenance of track and/or signalling. In addition it sometimes involves the slower train being brought to a stand, in contravention of our first principle. This is expensive in the misuse of motive power, rolling stock and train crews, while stopping and starting incurs braking and fuel costs and is liable to cause damage. The moral is to try to avoid the need for overtaking

by (*a*) increasing the speed of the slower trains; or (*b*) segregating trains of similar speeds on separate tracks. One method would be to use entirely different routes for passenger trains and freight trains. Another way would be to run fast trains at one part of the day and slow trains at another.

PROVISION AND MAINTENANCE OF TRACK

The provision and maintenance of track is performed by the Civil Engineer, with whom the Operating Department must work in close liaison. The Civil Engineer indicates the maximum speeds at which it is safe to run over each section of line and operating staff must pay regard to these. Much stress has been put on the benefits of high speeds but the operator is dependent on the Engineer providing a track that will permit them.

The method employed is for a general speed limit to be imposed for a section of line according to its general condition. Further restrictions, known as permanent speed restrictions, are defined for particular sections of line. These may be necessary on account of curvature, mining subsidence and so on. The term "permanent" is rather misleading as most permanent speed restrictions could be raised at a cost. From time to time major works permit the lifting of permanent speed restrictions, but this is comparatively rare and they do tend to continue over many years. The name does, however, distinguish them from temporary speed restrictions, which are specified by the Engineer from time to time over particular stretches of line owing to a deterioration in the condition of the track while it is being prepared for repair work, during the repairs, and immediately after the work. These temporary restrictions do not normally last more than a few weeks.

Much of the work of improving or maintaining track has to be performed concurrently with the running of the normal train service. This complicates the work of both departments, and a careful balance must be kept between their respective interests. When considering the timing of trains, this matter will be discussed in more detail.

The operator's responsibility is to make the best use of the track. This can best be achieved by adherence to the principles which have been outlined--maintaining movement, maximum speeds, capacity loading and prearranged planning. The signalling arrangements are a most important factor.

SIGNALLING

The basis of railway signalling is to divide the line into a number of *block sections* and to allow only one train in a section at any one time, thus maintaining a space interval between trains.

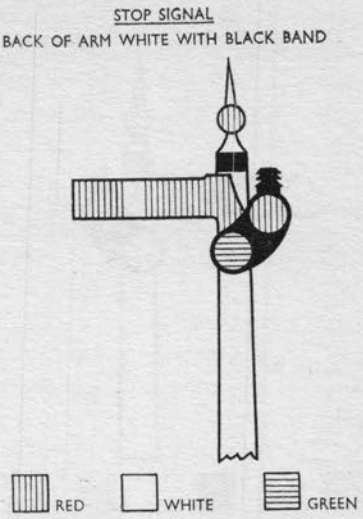


FIG. 6.

Manual Signalling. In places where automatic signalling or electrical power signalling has not been introduced, signalmen operate signal boxes manually, communicating with signalmen at adjacent boxes by code signals. Where semaphore signals are used they are operated by wire leads from the lever frames in the signal-box. The number of signals operated from one box relating to one line is not fixed. The basic need is a signal to control the entrance to the next section. Where this is a semaphore signal, it is coloured red (Fig. 6) and in the horizontal position indicates to a driver that it must not be passed. At night time when horizontal it shows a red aspect from the signal lamp at the junction of the post and the semaphore arm. The "proceed" indication is given by lowering or raising the semaphore arm through an angle of 45 deg. This places a green spectacle in front of the signal lamp instead of the normal red. In all semaphore signals the arm is weighted so that any fracture of the signal wire could not cause the signal to show a "proceed" aspect erroneously.

All signals of this type, with red semaphore arms and showing red or green lights during darkness, are known as STOP signals, because a driver must not pass the signal in the horizontal position. This is also called the "on" position or "danger" position. The signal controlling the entrance to the section is normally called the starting (sometimes the advanced starting) signal. To the rear of this signal is another stop signal, which is called the home signal. The home signal is usually close to the signal box and just to the rear of it. The line between the home signal and the signal controlling the entrance to the next section is known as *station limits*. So each block post will normally have a block section to the rear, then its station limits, then a block section in advance.

The movement of trains would be retarded if each driver had to reduce speed as he approached each block post in order to be prepared to stop at one of the stop signals at that post, bearing in mind again the long braking distance. Therefore, a yellow distant signal with a swallow tail cut out of the semaphore arm (Fig. 7) is placed to the rear of the stop

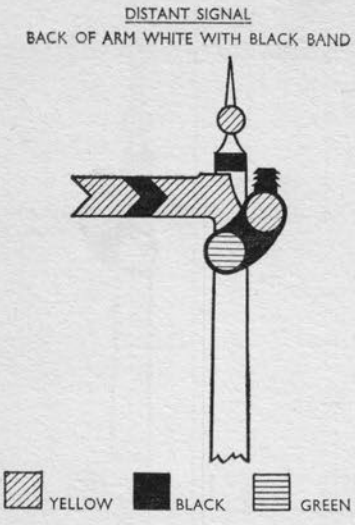


FIG. 7.

signals. This distant signal is also known as a caution signal to distinguish it from the stop signals. It shows a yellow light in the horizontal or "caution" position and a green light in the "off" position. It may be passed in the horizontal position. In that event the driver must be prepared to find the next stop signal at danger and must reduce the speed of his train accordingly. If the distant signal is in the off position (raised or lowered by 45 deg.), the driver may be assured that all the stop signals applicable to that line and operated from the same box are also in the off position. Interlocking prevents the distant signal lever from being operated until the other signals have been pulled off, and prevents the stop signals to which it applies being reversed before the distant signal. The driver must continue to look out for the stop signals, as in an emergency the signalman might have to reverse them before the train passed. The distance at which the distant signal is located to the rear of the home signal must depend on braking distances. In consequence, on a rising gradient the distance would be less than on a falling gradient. It may vary from 600 yards to over 1,000 yards.

The distant signal performs a most important dual function. It is an agent of safety, warning the driver in advance that he must be prepared to stop at the next stop signal. It is an agent of speed, permitting trains to travel much more quickly than would be possible if the driver did not know the likely aspect of each stop signal until it was sighted.

The signal layout described, i.e., a distant, a home and a starting signal, is one of the simplest forms. Some boxes have more than one of each type of signal, e.g., outer home and inner home, starting and advanced starting signals, for convenience of working. Most boxes also have a number of subsidiary signals, which may be discs or miniature semaphore signals, for shunting movements. So that it may be clearly understood to which driver the signalman is conveying a message, a signal only applies to one running line.

In the absolute block method of signalling the normal position (that is when there is no train present) is to treat the block section as closed.

Therefore, the normal position of the stop signals is danger and the distant signals is caution. Within each signal-box is a visual reminder to the signalman of the state of the immediate sections to the rear and in advance. This visual aid is known as a block indicator and normally has three positions: (1) Line Closed, or normal position; (2) Line Clear; (3) Train on Line, Train entered Section, or Section Occupied. It may also combine the bell tapper key with which the signalman communicates by prearranged code with his neighbouring signalman. Obviously there has to be a separate indicator for each section, and at a signal-box on a double line there would be four indicators; one for the Up line section to the rear, one for the Up line section in advance and two similar indicators for the Down line. Up and Down are the references used to identify the lines according to their direction.

The routine signalling of a train from signal-box *A* to signal-box *B* would be as follows. Signalman *A* calls the attention of signalman *B* on the bell tapper key, and asks in the prearranged code: "Is the line clear for an express passenger train to leave my signal-box and travel to yours?" The code for this is four consecutive beats on the bell. This sounds at *B* and the signalman there, if he is prepared to accept the train, acknowledges the four bells by repetition, and places his block instrument to the Line Clear position. This causes the corresponding instrument at *A* to also show Line Clear. If the block instrument and *A*'s starting signal are interlocked, the latter signal cannot be pulled off until Line Clear is shown. Before *B* can accept, it is not sufficient only for the Section *A-B* to be clear. There must also be an additional clearance, normally a quarter of a mile, in advance of *B*'s home signal. This is an additional safeguard to cater for the possibility of a driver misjudging the braking distance when approaching the home signal at danger.

Assuming there is the clearance, *B* accepts and by placing the block instrument to Line Clear enables *A* to pull off his signals, which he does, and the train leaves. *A* advises *B* that the train is entering the section by two beats on the bell, and *B* places his block instrument (and therefore *A*'s instrument also) to Train on Line. As the train passes *A*'s signals, they are immediately returned to the normal position to protect the train. In the meantime *B* is calling up *C* to obtain permission for the train to go into the next section. Remember that, if the train is to be kept on the move at full speed, it is necessary for *B* to get his distant signal off before the driver sees it. He cannot do this until *C* has accepted it and he has pulled all his stop signals off for the passage of the train. This time it will be *C* who manipulates the indication of the block instrument for the section *B-C*. You will observe that it is always the signalman in advance who works the indicator, and the aspect which he

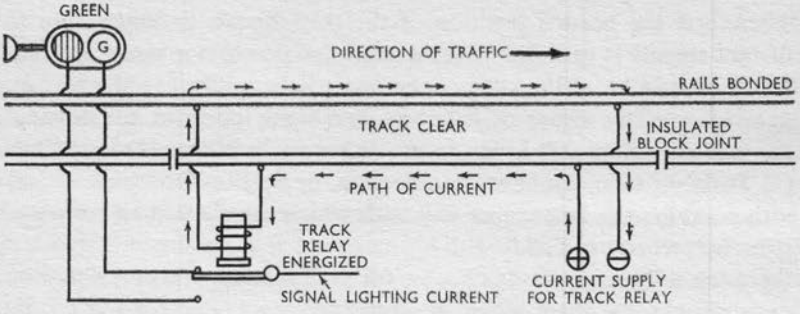


FIG. 8. *Current flows along the rail to the relay which, when energized, closes its contacts, completing a circuit to the green aspect.*

displays is repeated in the signal-box in the rear. It is always the signalman in advance who controls a section. The signalman to the rear of a section must always ask for his permission before allowing a train to enter.

A useful device to increase the safety in this type of signalling is the track circuit. A track circuit is formed by bonding the running rails to form an electric circuit, which is closed through an electrical supply and a relay, as in Fig. 8. The arm of the relay is attracted by the current passing through the circuit, and in this position completes another electric circuit. When a train or a vehicle moves on to a section of line, the current, instead of passing to the relay, passes through the wheels and axles of the vehicles. This breaks the full circuit and the relay arm falls down breaking the second circuit. The movement of the relay arm is sometimes used to indicate on a track diagram in the signal box the actual position of the train. This is particularly useful in fog or when visibility is restricted for any reason. Sometimes it may be used to give a visual reminder to a signalman that a train is standing at one of his signals. It may also be used to prevent levers being operated which would set up or authorize conflicting movements on the track. In fact, the track circuit can be used to operate any electrical device; so why not exploit this in order that signalling can become automatic? This is what is meant by automatic signalling.

AUTOMATIC SIGNALLING

The normal position of signals in automatic signalling is OFF, in contrast to the situation in manual signalling where the normal position of signals is ON. Under this method, which is usually (but not necessarily) combined with colour light signals, the signal is put to danger as

soon as a train has passed it by the occupation of a track circuit immediately ahead of it (see Figs. 8 and 9). When the train has cleared the section and passed into the one ahead the red danger signal is replaced by a yellow aspect. This indicates to the driver of a following train that the signal may be passed but he must be prepared to stop his train at the next signal. When the first train has travelled beyond yet another signal plus a safety overlap, the yellow aspect will be replaced by the normal green light.

Where the distance between a caution signal exhibiting one yellow light and the stop signal is insufficient to bring trains to a stand at the stop signal, the caution signal is preceded by one or more signals exhibiting two yellow lights, one above the other. The driver approaching a red stop signal in this case will see first a preliminary caution (two yellows), then a caution (one yellow) and finally the red light of the stop signal. The signal posts concerned must have four aspects, red, yellow, double yellow and green. A three-aspect signal has red, single yellow and green lights only.

COLOUR LIGHT SIGNALLING

Colour light signals (operated from a signal-box or used in automatic signalling), which are high-intensity coloured electric lights (red, green and yellow) have a number of advantages as compared with semaphore signals. They are as follows:

(1) They can be more easily seen from a distance.

(2) During fog, the divergent light beams which are sent out are sufficiently strong to penetrate for some distance, and they cause the fog in the vicinity to glow with the colour they are exhibiting. This precludes the necessity of employing "fogmen" armed with detonators,

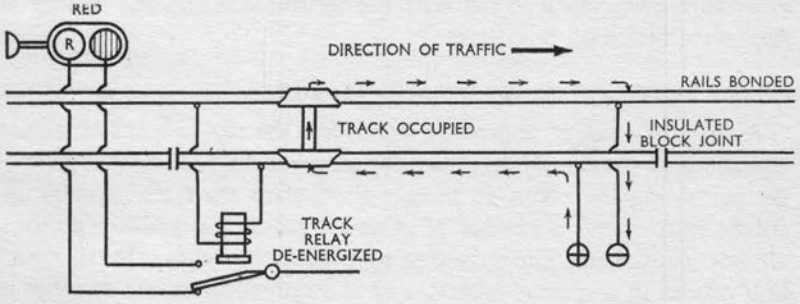


FIG. 9. *When the circuit is occupied by a train, current returns through the wheels and axles to the negative pole of the supply. The relay is deprived of current and opens its contacts, completing a different circuit. This extinguishes the green aspect and lights the red aspect.*

which has always been an expensive addition to semaphore signals during foggy weather. It also speeds up train movement during moderate fog.

(3) They can be sited close to the level of the driver's eyes. This is frequently not possible with semaphore signals, as it is sometimes necessary to give them a sky background in order that they can be read from a distance during daylight.

(4) They lead to a simplification in signalling. Many readers may have seen the signal gantries with a formidable array of semaphore arms at large junctions. A single colour light signal can indicate the route to which a train is switched by the use of theatre-type indicators displaying a code letter or number (Plate 1). Alternatively, at junctions a line of white lights projecting to left or right indicates to the driver the route for which the points have been set. The danger of a driver reading a signal which applies to another track is reduced in consequence. They are also simpler than semaphore signals because the same type of indication is employed day and night.

(5) With the four-aspect signals a driver has an earlier intimation of the state of the line ahead, than he would otherwise have. Armed with this knowledge he may reduce speed earlier. If his train is following another, which is moving more slowly, he can reduce speed to the same level and thereby keep his train on the move. In these circumstances the one-yellow aspects would probably be changing to double-yellow as he approaches. The principle of keeping moving is most important in this particular field, as a train which is brought to a stand may take three or four minutes to be restored to its proper running speed. A train which has merely slackened off can resume full speed with less time lost. This makes for more punctual running for the particular train and is also more economical in the time the section is occupied. This is an important factor on busy lines.

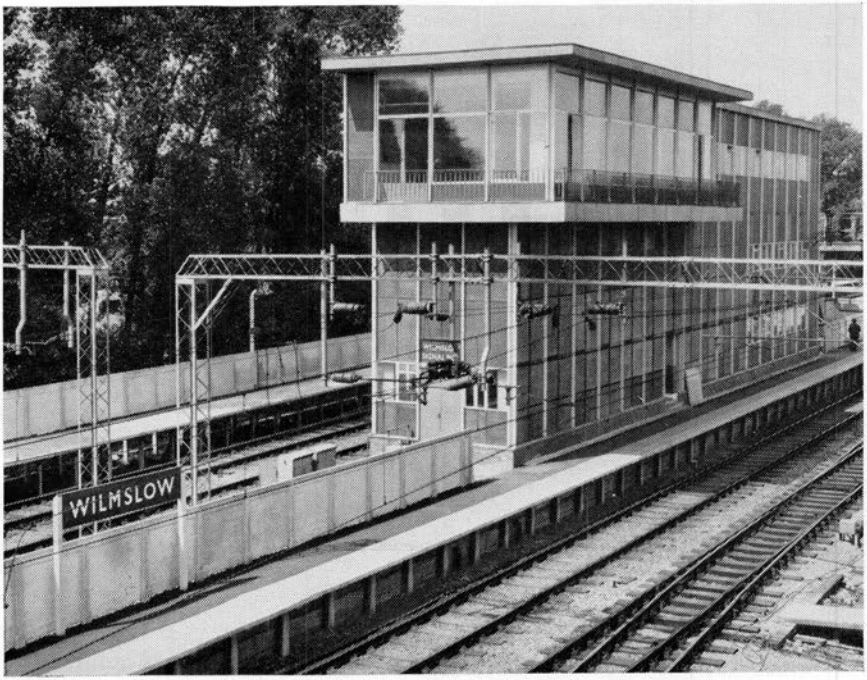
POWER SIGNAL-BOXES

An effective way of improving methods is the replacement of manual signalling, as previously described, by automatic colour light signalling. By permitting the trains to protect themselves via track circuits and colour light signals a number of gains are secured in addition to those already mentioned. The reduction of human intervention in the signalling results in increased safety, and the reduction in the number of signalmen employed shrinks the wages bill.

Trains still have to be switched from one track to another and into and out of sidings and this calls for some signalmen and some signal-boxes. When points had to be operated manually from a signal-box by

PLATE 1. *Four-aspect colour-light signal at St. Pancras (London Midland Region). This signal is fitted with a theatre-type indicator which shows the driver the route to be taken.*

PLATE 2. *The exterior of Wilmslow (London Midland Region) power signal-box.*



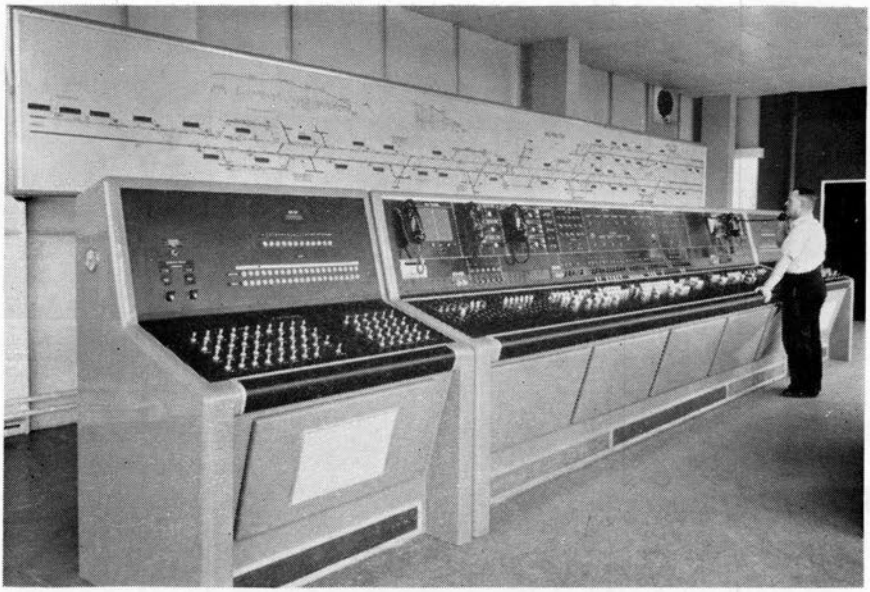


PLATE 3. *The interior of Wilmslow power signal-box, showing the control panel and diagram of area controlled.*

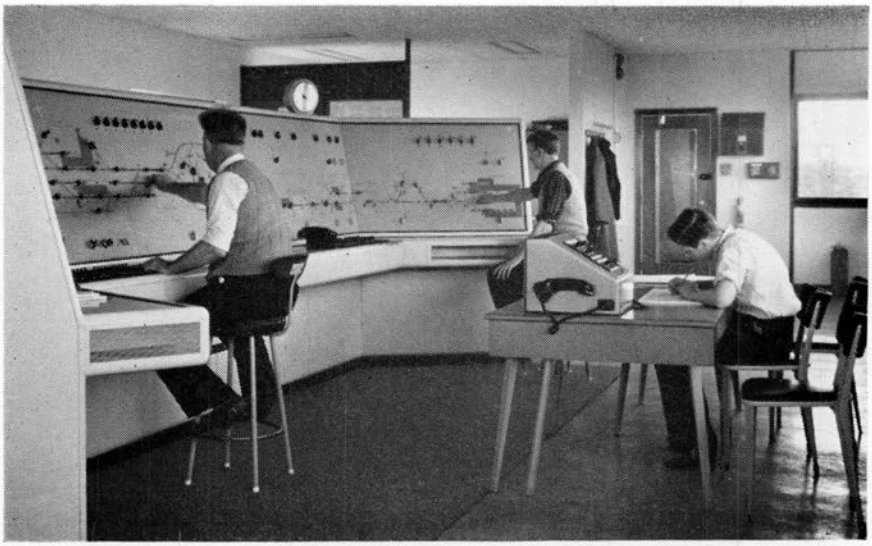


PLATE 4. *Control panel at Sittingbourne (Southern Region) power signal-box. The right-hand end of the panel is occupied by the Centralized Traffic Control section which signals trains on the single line between Sittingbourne and Sheerness.*

rodding, statutory restrictions were imposed on the maximum distances between signal-boxes and points. As the power (hydraulic, pneumatic and electric) operation of points developed, these restrictions no longer applied. Recent technical developments have permitted the centralization of point switching and the operation of the corresponding signals at cabins situated many miles from the points concerned. This has resulted, and will continue to result, in the elimination of numerous mechanical boxes and their replacement by fewer power-worked boxes (see Plate 2). The signalmen at these posts no longer offer trains to and accept trains from adjacent boxes. Information is passed forward from box to box on train-describing apparatus, which enables the signalmen to identify particular trains. They can then set up the required route with the pressing of a button or the flick of a switch on the control panel (Plates 3 and 4). Interlocking, now achieved electrically instead of mechanically, prevents the route being set up unless it is safe. If it is not immediately safe, some apparatus stores the route setting which has been indicated, until it is safe, thus allowing the signalman to devote his attention to other trains or other matters.

After the route has been established, the points move to the required position, and when it has been detected electrically that the points are fitting properly, clear signals for the movement are set up automatically. After the train has passed, the signal goes to danger, but an indication remains on the panel showing how the points are set until the route is cancelled by further operation of the buttons or switches.

The concentration of the regulation of trains in fewer hands is safer, reduces the number of signalmen required, and helps in the adherence to the first principle of maintaining movement with the minimum of interruption. The last mentioned results from the signalman having charge of the working of a large area instead of sharing it with a number of men each of whom has an imperfect knowledge of what his colleagues are doing.

BANALISATION

Instead of allocating tracks to traffic in one direction only, greater flexibility and more intensive use of the track may be achieved by arranging for the common use of track for traffic in both directions. This has been made possible by advances in signal engineering technique whereby coded electric impulses are passed over a wire to a specified point where they are decoded to control the safe functioning of signals. It must be accompanied by facing cross-overs, i.e., switches, which permit trains to transfer from one track to another without reversals, and preferably without severe speed restrictions.

There is no merit in introducing this over long distances except where traffic tends to flow predominantly in one direction at particular times or seasons. Such a lack of balance would permit, at those times, both lines to be used for trains travelling in one direction. However, it is a most useful facility at busy stations and junctions. The cost of introducing the necessary signalling equipment is quite high, and one must be satisfied that the improved flexibility which it gives justifies the expenditure. It is known by various other names, including two-way working, dual direction working, and reversible working.

CENTRALIZED TRAFFIC CONTROL

Traditional methods of signalling trains over single lines consist of manual signal boxes at each crossing place. Drivers are authorized to enter on the single line only when the relevant signals are pulled off and also when they have received a "token" of some kind. These tokens take various forms, but the principle is that only one token is available at any one time. This gives an assurance that only one train has been authorized to enter a section at one time, thereby avoiding the possibility of a head-on collision.

By the use of the coded impulses previously mentioned it is now possible for single lines to be operated remotely, thereby eliminating signal-boxes at crossing places. This signalling system is known as Centralized Traffic Control and the electronic apparatus prevents two trains being authorized to enter a section of single line at the same time. It is rather expensive to introduce. In spite of the economies in signalmen which it permits, it is not seen on a wide scale because of the uncertainty of the future of many single lines which, as has already been explained, are usually difficult to run without entailing a financial loss.

LINE CAPACITY AND LINE OCCUPATION

The problem of line occupation is a most important one and at this stage it might be a good idea to define the terms used in connection with it. *Line capacity* is the maximum number of trains which can be passed over a given length of line in a specified period. *Line occupation* is the actual number of trains which do pass over a line in a specified period.

You will recall that one of the principles of operation is that the capacity of a unit is not fixed but depends on the method of using it. Line capacity is no exception. By definition, it is not a satisfactory term because the important thing is the traffic capacity of the line, rather than the number of trains which may be accommodated. This depends on the loading of the trains. A light engine takes up its share of line

capacity in the same way as a well-loaded train. Therefore, to obtain maximum use of the line for traffic purposes, light-engine movement and empty stock trains both freight and passenger must be reduced to a minimum. The loaded trains should convey loads as near to capacity as possible.

Having accepted the shortcomings of talking about line capacity by the number of trains instead of the amount of traffic, we must still remember that it is not a fixed quantity. It depends on:

(*a*) The time trains take to pass through it. Line capacity is higher if trains clear the section in a short time instead of a longer one; i.e., if trains keep on the move and move quickly.

(*b*) The difference between the speeds of the fastest and slowest trains. The less difference in speeds there is, the higher will be the line capacity.

(*c*) The arrangement of trains which run at different speeds. If trains of similar speeds are grouped together line capacity will be increased.

(*d*) The length of the block sections within the piece of line concerned. If the block sections are shorter, the trains take less time to run through them and consequently capacity is higher. Where manual signalling is employed to shorten the sections, one method is to introduce additional signal-boxes. This increases the cost. A slightly cheaper way is partially to introduce automatic signalling to create an Intermediate Block Section.

On many lines there are certain times when line occupation is light. Opportunity should be taken of this to reduce signalling costs by closing intermediate signal boxes which are not required during this period. To permit these signal boxes to be closed, a switch is provided in the box which, when operated, permits the code signals to be transmitted direct between the boxes on each side of it. It is necessary for the relevant signals of the closed box to be left in the off position until it reopens.

(*e*) The variation in length of the block sections. The more equal the block sections are—in terms of the time taken to run through them—the higher the capacity. With manual signalling, block sections are often uneven, as signal-boxes have been located at particular spots for level-crossing operation, to work junctions or connections into sidings or for other reasons unconcerned with line capacity.

(*f*) The type of signalling employed. Automatic signalling increases the capacity of the line by eliminating the time taken for the exchange of code signals between signal-boxes and also the time it takes a signalman to operate his levers after the train has been accepted. It

also increases capacity because the installation of automatic colour light signals presents the opportunities to shorten block sections and to equalize them. Shortening is facilitated by the dual role of distant signal and stop signal, which colour light signals are able to perform.

Under (*d*) and (*e*) you will observe that when discussing shorter sections and equal sections, reference was not made to distances but to the time taken for trains to pass through them. The relationship between distance and time is not as direct as one may imagine at first. For example, *A* to *B* might be two miles and *B* to *C* three miles. However, because *B* is at the summit of a hill, trains climbing up the hill from *A* may take longer than they do descending the three miles downhill between *B* and *C*. So please remember it is the time taken, not the distance, that counts.

It is obvious that slow trains reduce line capacity as compared with faster ones. It is not so obvious why minimizing the difference in speeds and grouping trains of the same speeds has a beneficial effect on line capacity. This can best be shown by an example. In order to understand the example, it is necessary to enlarge upon the principle of one train per section as it affects line capacity.

HEADWAYS

If in fact there was a train in the section *A* to *B* and another in section *B* to *C*, the second train, i.e., the one between *A* and *B* would very likely pass *B*'s distant signal at caution and the driver would be obliged to reduce speed in order to be prepared to stop at *B*'s home signal. As it has been agreed that the highest speeds are desirable, it is necessary to space the trains even further apart than one block section. How far must trains be apart, in order to ensure that the distant signal is in the off position by the time it is sighted by the driver of the second train?

In Fig. 10 the signals for *A*, *B* and *C* signal-boxes are shown. The aim is to get all *B*'s signals off for train No. 2 before the driver sees the distant signal. You will recall that the distant signal cannot be pulled off until the home and starting signals are in the " line clear " position. *B* cannot pull them off until *C* has accepted train No. 2. *C* cannot accept it until train No. 1 has gone a quarter of a mile beyond his home signal. It will be seen from the diagram that train No. 1 is just past *C*'s starting signal and train No. 2 is just past *A*'s starting signal. In other

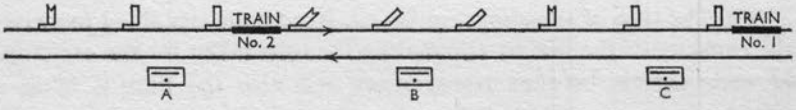
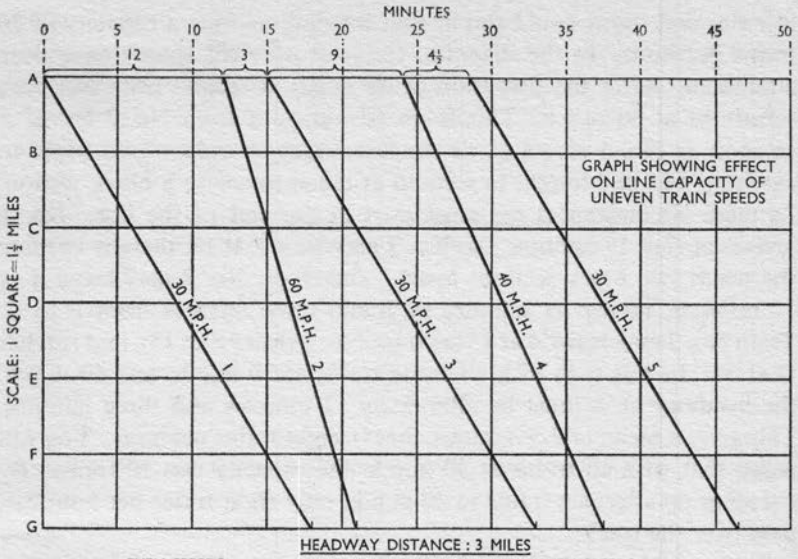


FIG. 10.



EVEN SPEEDS			UNEVEN SPEEDS			
M.P.H.	HEADWAY TIME	TRAINS PER HOUR	M.P.H.	HEADWAY TIME ALTERNATIVELY	MEAN	TRAINS PER HOUR
60	3 MIN.	20	30 AND 60	12 MIN. AND 3 MIN.	7·5 MIN.	8
40	4·5 MIN.	13·3	30 AND 40	9 MIN. AND 4·5 MIN.	6·75 MIN.	8·8
30	6 MIN.	10				

FIG. 11.

words, approximately two block sections is the required spacing for unimpeded movement. This is known as *headway*. The example quoted would apply with quite a number of variations in the speeds of the two trains, but there are exceptions. For example, where a slow train was following a faster one, train No. 2 might take so long to move from *A*'s home signal to sighting *B*'s distant that train No. 1 could have moved through the *B*—*C* section and beyond the clearance point in the requisite time. The capacity of a piece of line is, therefore, governed by the time taken for a train to pass through the two longest (in time, not in distance) adjacent sections.

Let us now see why minimizing the difference in speed increases the potential of a line. In Fig. 11 a stretch of line between *A* and *G* is illustrated. It is divided into six equal sections of 1½ miles each. The first train leaves *A* at zero and 18 minutes later clears *G*, i.e., nine miles in 18 minutes = 30 m.p.h. We have agreed that approximately two block sections are required between trains. Therefore, successive trains also at 30 m.p.h. could leave at six-minute intervals without impediment. This would give a line capacity of ten trains an hour. With trains at 60 m.p.h. the first train would clear two sections in three

minutes and trains could run at that interval, making a capacity of 20 trains per hour. In the diagram, trains at different speeds have been alternated. After the first train at 30 m.p.h. a second train has been scheduled at 60 m.p.h. This is no advantage if train No. 2 leaves *A* as soon as No. 1 clears *C*, as the faster second train would begin to catch up and be brought to a stand at the entrance to a block section. In these circumstances we must start at the end of the line. No. 1 arrives at *G* at 18 minutes. So No. 2 may pass *E* at 18, thereby keeping the trains two block sections apart. Therefore, No. 2 may leave *A* at 12 minutes, taking six minutes to *E* and three minutes from *E* to *G*. Train No. 3 may leave *A* at 15 (as train No. 2 clears *C* at 15), and reaches *G* at 33. In this case with alternate trains at 30 m.p.h. and 60 m.p.h. the headway at *A* must be alternately 12 minutes and three minutes. This gives a mean of 7·5 minutes, that is, eight trains per hour. You will recall that with all trains at 30 m.p.h. the capacity was 10 trains. By speeding up alternate trains to 60 m.p.h. only eight trains per hour can pass over the track.

Trains 3, 4 and 5 show the headway necessary between alternate trains at 30 m.p.h. and 40 m.p.h. in the same way. In this case the alternate headway margins are 9 and 4·5 minutes, giving a mean of 6·75 minutes and a capacity of 8·8 trains per hour, which is slightly better than that given by successive trains at 30 and 60 m.p.h. This diagram illustrates that:

(*a*) line capacity is reduced by running trains at uneven speeds instead of grouping trains at equal speeds.

All trains at 60 m.p.h.	20 trains per hour.
All trains at 30 m.p.h.	10 trains per hour.
Successive trains at 30 and 60 m.p.h.	8 trains per hour.

(*b*) By minimizing the difference in train speeds, line capacity is increased

30 and 60 m.p.h.	8 trains per hour.
30 and 40 m.p.h.	8·8 trains per hour

This again emphasizes the importance of bringing up the speed of the slowest trains.

AUTOMATIC WARNING SYSTEM

The reader will readily appreciate the important role of the distant signal. In the clear position it is the authority for the driver to maintain the authorized speed of his train. In the caution position it warns him to be prepared to stop at the stop signal to which it applies. If a driver

fails to act on its caution aspect for any reason, the chances of his being able to stop his train at the stop signal are poor owing to the long braking distances. In a number of accidents the missing of the caution aspect of a distant signal has played an important role. By giving the driver an audible signal as well as a visual signal, the possibility of the caution message being unheeded is reduced. This is done by the Automatic Warning System, which is rapidly spreading over the more important lines.

Between the rails, about 200 yards before each distant signal, there are two magnets. The first is a permanent magnet. The second is an electro-magnet and is only energized when the signal shows " Clear." On the under-side of the locomotive is a magnetic receiver connected to electric circuits in the driver's cab, which operate according to whether they pass over one magnet (the permanent one) or two magnets (the permanent one plus the energized electro-magnet). The former, that is the Caution signal, causes a horn to sound in the cab. The latter, i.e., the Clear signal, causes a bell to ring.

On hearing the horn the driver must pull a resetting handle. If this is not done within three seconds the brakes of the train are automatically applied. Pulling the resetting handle has the following effects: (1) it stops the horn; (2) it causes a yellow-and-black segmented indicator to be exhibited. This is a visual reminder to the driver that the last distant signal was at caution. It is obliterated when the train passes over the next permanent magnet. Having applied the resetting handle the driver prepares to reduce the speed of the train so that he is able to stop at the stop signal if necessary.

As with all railway signalling equipment the principle has been adopted that equipment failure, however caused, must result in a safe indication. In this case a failure in the track or engine equipment gives a caution to the driver. The equipment, of course, is intended to assist the driver and does not relieve him of his responsibility to observe signals and to act on them. When visibility is bad the driver's knowledge that he will receive an aural indication as well as a visual one at distant signals makes his unenviable task a little more tolerable. In these conditions it is an especially useful safety device.

LEVEL CROSSINGS

The main division in level crossings is between public crossings and occupation crossings. The term *occupation crossing* is used in a general sense to denote an unattended crossing having field gates opening outwards from the railway; this includes occupation crossings proper, namely, those at which the railway intersects track or roadway already

in existence when the railway was built, and also accommodation crossings provided to connect lands severed by the construction of the line.

The public crossings, most of which have gates, pose the main problems to the operator as they are situated on the busier roads and he is faced with the expense of providing staff to operate them. Some crossings are worked from signal-boxes and the gates are interlocked with the signals. They may be operated (*a*) mechanically from the signal-box; (*b*) by power from the signal-box, but this is rare; (*c*) manually by the signalman. Others are operated by crossing keepers. Sometimes these gates have no interlocking, and safe working is dependent on the gatekeepers' integrity and the care with which they observe the regulations. It has become increasingly difficult to obtain staff of the right quality for this job.

Another feature has been the enormous increase in road traffic. It is frequently necessary for gates to be closed for five minutes or more before the passage of the train and the delays are becoming increasingly serious. To avoid the delay, motorists are tempted to take risks and motor vehicles frequently collide with gates. In consequence it is necessary to consider replacing heavy wooden gates, which are common throughout the country, by lifting barriers.

Lifting barriers may be of the following kinds:

(1) Manned, i.e., operated by a signalman or crossing keeper as are the gates mentioned earlier.
(2) Remotely controlled. These may be worked from a signal-box or manned crossing some distance away. They may be operated mechanically or electrically.
(3) Operated automatically. The barriers fall when a track circuit or treadle is operated by approaching trains.

Manned barriers make no appreciable reduction in the delay to road traffic, but they are lighter and slightly quicker in operation than gates, cheaper to maintain, and more easily replaced if damaged. They are required to cover the full width of the road, and the barriers have skirts to prevent entry beneath them when in the down position.

Remotely Controlled Barriers. The introduction of remotely controlled barriers may help to reduce the number of crossing-keepers required. The person operating the barriers may be able to observe the approaching road traffic by closed-circuit television or other means. In any case, at those barriers which are normally open to road traffic, double flashing red signals operate when the barriers are about to be lowered. At other crossings the barrier may be normally closed to

road traffic, and road users are then required to use a call plunger to request the lifting of the barriers.

Automatic Barriers. Apart from reducing the number of crossing-keepers employed, these barriers are valuable in eliminating those accidents which result from misunderstanding between crossing-keepers and signalmen or which occur through crossing-keepers' carelessness. Perhaps the main advantage is the considerable reduction in delays to road traffic. The present delays of five minutes or more may be reduced to not more than 45 seconds. This should lead to a reduction in the collisions between motor vehicles and the crossing protection. In this case barriers which extend only half-way across the road are used. Half barriers are essential so that road vehicles do not get trapped. As with remotely controlled barriers, flashing red lights warn the approaching motorist when the barriers are about to be lowered. These lights must be supplemented by an aural warning. In planning the operation of the crossing it is necessary to take into account the possibility of a second train approaching in the opposite direction when the barrier is already down, and the positioning of track circuits and treadles must make allowance for the possible phasing of arrivals of trains in two directions.

Statutory restrictions are imposed on the introduction of automatic barriers. These restrictions are much more severe than those imposed in other countries. For example, the number of vehicles must be less than 1,000 a day, whereas in Holland such crossings are in operation with over 10,000 vehicles a day. The most satisfactory solution for all concerned is to provide bridges rather than level crossings where the former can be economically justified.

SUMMARY

1. *The railway operator has to provide his own track, which his competitors do not. Therefore he must exploit it to the full.*
2. *This must be done by using the minimum amount of track.*
3. *The best use is made of track by automatic signalling, by high general speeds and by running trains at equal speeds.*
4. *Conflicting movements should be avoided in track layouts.*
5. *Every precaution should be taken to prevent obstructions occurring.*
6. *Overtaking should be avoided wherever possible.*
7. *When 5 and 6 are inevitable their effects can be minimized by the maximum flexibility of alternative routes and tracks.*
8. *Concentration of signalling at fewer boxes reduces manpower and speeds movement.*

CHAPTER 3

Freight Rolling Stock

AN examination of the accounts of British Railways will show that the largest single item of mobile capital equipment is freight rolling stock (F.R.S.). Far more money is tied up in wagons and containers than in locomotives, coaching stock, or road vehicles. It is a large amount of capital because the number of vehicles in the freight rolling stock fleet is formidable. Only a small proportion of the wagon fleet is privately owned now, whereas before nationalization quite a substantial part of it was owned by traders. It is a large amount of capital because the cost of individual wagons is high. It has gone up as wagons have become more complicated. There is a great contrast between the modern wagon with its vacuum brake, hydraulic buffers, and rigid couplings, and the box on wheels of former days which had no train brake, simple spring buffers and loose couplings. In addition, many more modern wagons are specially equipped for the conveyance of particular commodities.

It is the job of the operator to ensure that the enormous capital invested in freight rolling stock is properly employed in order to earn adequate interest on the investment. This involves loading to capacity where traffic permits, keeping wagons moving under load and moving them as quickly as possible. There is much scope for improvement in each of these directions. If these things are done, another principle will apply—"the capacity of an operating unit is not fixed." In consequence of better loading, keeping moving and moving faster, the same amount of transport can be performed by fewer vehicles. If traffic levels remain fairly constant, this will enable the size of the fleet to be reduced, thus releasing capital for other purposes. Less interest payments on capital, lower maintenance and depreciation costs and fewer sidings required on which to stand freight rolling stock will contribute to reduced costs of operation.

Another benefit to be derived stems from the increased availability of wagons for loading, thus reducing or eliminating those occasions when the operator is unable to meet promptly the demand for wagons for traffic. The first step in using freight rolling stock efficiently is to arrange for vehicles of a satisfactory design to be supplied for the fleet.

FREIGHT ROLLING STOCK

TYPES AND DESIGNS

The main considerations are: (1) suitability for traffic to be conveyed; (2) economy in operation, which will depend on initial cost, maintenance and depreciation charges, availability for traffic purposes, range of utility, and capacity.

Rail transport can expect to be offered freight of all kinds for conveyance. Different traffics demand different types of vehicle. Petrol, steel castings, coal and cattle each call for entirely different designs. However, it is neither possible nor desirable to provide a special vehicle for every type of commodity. A vehicle designed for a particular traffic may enable a better loading per vehicle to be obtained, it may facilitate the most rapid loading and unloading, and it may carry the freight more safely. But, in order to justify its construction, it must be anticipated (or better still—guaranteed) that sufficient traffic will pass to enable a reasonable utilization of the vehicle to be obtained. A highly specialized wagon may not be of use for any other type of traffic at all.

The basis of the fleet must be, therefore, the general utility vehicles—the ordinary open wagon, the covered van, and the mineral wagon. Within each of these main groups there are some wagons which have been designed for the conveyance of particular freights.

Open wagons (*excluding mineral and steel-carrying wagons*). These are divided into three main sections according to the height of the wagon sides—low, medium, high. The low-sided wagons, which usually have end doors that can be dropped down, are particularly convenient for loading vehicular traffic of all kinds. These can be driven straight on to the wagon at a loading dock. High-sided wagons account for about three-quarters of the open goods wagon fleet, and have a wide utility. They are easy to load and unload by crane. Their main disadvantage is that, if the freight is susceptible to damage by wet, it is necessary to cover the load with a sheet. Putting on wagon sheets and taking them off is expensive in time and labour. In any case sheeting of loads is not as effective a protection from wet as a wagon roof. To promote more effective sheeting, a number of open high-sided wagons are fitted with a sheet support bar (Plate 5). In the vertical position it supports the centre of the sheet so that it slopes evenly down to the sides of the wagon. The failure to maintain a constant slope with a wagon sheet may result in rain collecting in pools in any hollows that have been left. After a time the water may then seep through on to the contents. More effective protection may be offered by wagons with sliding roofs recently introduced into service.

The use of these wagons also eliminates the time spent by staff in sheeting and unsheeting.

There are many open wagons which are designed for the conveyance of special traffics, including motor cars (see Plate 6), bricks (including palletized bricks), china clay, pig iron and sand. There are also substantial numbers of wagons constructed to carry containers, and wagons fitted with shock-absorbing equipment for fragile loads.

Covered Wagons. The covered wagon stock also includes vehicles with shock absorbers for conveyance of traffics which are particularly susceptible to damage. The ordinary covered van is ventilated for the benefit of perishable traffics, e.g., fruit and vegetables. For seasonal traffics such as fruit, it is important that a general utility vehicle should be used. A wagon suitable only for the conveyance of a seasonal traffic would be unemployed outside that season. Wagons for frozen meat, fish and bananas are insulated to keep temperatures inside the van at the right level, thus maintaining the load in good condition. There are also specially built pallet vans for the exclusive conveyance of pallet loads (Plate 7). They have extra wide doors to make loading and unloading easy and a special floor for the support of pallet handling machines.

One of the main influences on the composition of the covered wagon fleet has been the increased demand for transport in bulk. Bulk transport saves the sender packing costs, speeds up loading and unloading, reduces labour costs and permits maximum vehicle loading. The bulk material van is suitable for a wide range of materials and is discharged through hoppers. Some materials demand more specialized treatment. Cement is an example. It is often conveyed loose in a 20-ton all-steel closed wagon which is pressurized for pneumatic discharge of the contents. Loading is performed through roof doors. This is the *Presflo* wagon, suitable also for salt, pulverized fuel and various other commodities. There are also bulk grain wagons.

Tank wagons for the conveyance of bulk liquids are mainly privately owned. The Transport Act of 1947 did not provide for them to be taken over. Subsequently there has been a reluctance on the part of the railway to incorporate new tank wagons in the railway fleet. This brings its own problems to the operator, as many private wagons are quite old and are not suitable for conveyance on the faster freight trains. It may also partly explain why, in Great Britain, the railway has failed to secure a better share of the conveyance of petrol, oil, chemicals, and other liquids in bulk. Consignors find it difficult to understand why they should be expected to lay out capital for new tank wagons, when most senders have wagons provided for their

products by the railway. There is the complication that tank wagons often have to be confined to the conveyance of a particular liquid. However, the railway is now prepared to hire tanks to traders.

Mineral Wagons. In the two classes of wagons already mentioned the main consideration is usually cubic capacity not carrying capacity. There are comparatively few traffics which can be loaded to the weight capacity of the wagons. It is a different situation with coal, iron ore and other mineral traffics which are of heavy bulk.

There has been a gradual increase in the average capacity of the mineral wagon fleet in recent years owing to the new wagons having greater capacities than the wagons withdrawn. This is to be welcomed, as it gives advantages which include:

(*a*) *Increased ratio of pay load to tare weight.* This reduces the gross weight to be hauled. A given quantity of minerals can be hauled with fewer locomotives, and train crews, reduced line occupation and less wagons.

(*b*) *Economy in empty wagon haulage.* Reduction in tare weight enables the haulage of empty wagons to be carried out more economically, for the same reasons.

(*c*) *Reduced ratio of length to capacity.* A 24-ton-capacity wagon is by no means twice as long as one of 12 tons capacity. Reduction in length in relation to the weight of its load leads to economies in the provision of sidings both in yards and at terminals.

It should be noted that the maximum loading of trains is not always determined by the weight that the locomotive can pull at a certain speed. Sometimes trains have to be restricted to a particular length (i.e., so many wagons) on account of the length of refuge sidings, loops etc., *en route*, or because the yard or depot which is the destination of the train has short reception sidings. Minimum wagon length in relation to load is, therefore, a matter of some consequence.

(*d*) *Higher capacity per wagon results in fewer wagons being required.* The consequence is a reduced surplus of wagons at off-peak periods. This is particularly important with coal. Coal production during the main miners' holiday period is only about a half of the average output, and considerably less than half of the peak output weeks. Scores of thousands of coal wagons have to be stabled during the slack periods. Finding accommodation for surplus mineral wagons during the summer months is a problem for the operator. He may be obliged to retain sidings which could otherwise be dispensed with, solely for this purpose. This is expensive. The process of transferring the wagons to the storage accommodation, of taking them out again later when required

and of moving them back to the place at which they are needed is also costly.

(*e*) *Reduction in shunting costs.* If the same amount of traffic is contained in a reduced number of wagons, there is less shunting of wagons to be performed for a given quantity of traffic both in marshalling yards and at terminals.

(*f*) *Reduction in wagon provision costs.* Less wagons to cope with an equal amount of traffic, means less expense in examining wagons for defects, in maintaining them and in wagon building costs.

(*g*) *Reduced tractive resistance.* When a wagon is being hauled by a locomotive, frictional resistances are set up between the wheel and the rail and also in the axle boxes. The fewer of these there are, the less resistance is encountered.

In view of these substantial operating advantages, what are the limiting factors on increasing the size of mineral wagons? First of all, there is the increased cost of a larger wagon. Fortunately production costs do not rise proportionately with the carrying capacity of the wagon. Up to 24½ ton capacity, an increase in capacity does not incur proportional additional building costs. At this level the tare weight may be expected to approach 10½ tons giving a gross weight of 35 tons, which is the maximum load which may be conveyed on two axles if the wagon is to be given reasonable freedom from restrictions on route availability.

As the quality of track is improved it will be possible to raise the limit to 17½ tons per axle which applies at present. Already a 20-ton-axle-load vehicle may be fairly widely used, and when vehicles operate on a regular run even higher axle loads may be acceptable. When these limits are exceeded, wagons must be equipped with bogies instead of axles and the cost of wagon construction rises disproportionately around this level. This is not to say there is no scope for vehicles with bogies. Providing traffics can be secured which make good use of the enlarged capacity of such vehicles, and which keep the wagon in regular use, the additional cost and maintenance expense of a bogie vehicle may be justified. As they have a greater overhang on bends, one must be satisfied that they can clear all obstructions in private sidings where they are to be used.

Secondly, there are the limitations on the size of wagons to be taken into account. The maximum permissible dimensions of mobile equipment on British Railways are more limited than on many other railway systems. The rail gauge of 4 ft. 8½ in. is quite common, but because of small-bore tunnels, and because of bridges and other fixed equipment with small clearances, it is necessary to limit the height and width of

vehicles of all kinds more severely than in most other countries. This is a consequence of the building of most of the tracks in Great Britain in the middle of the last century when the need for large dimensions for rail vehicles was not foreseen. It is not only the narrow clearances on railway property that have to be taken into consideration. Most mineral traffic originates and terminates in private sidings; i.e., sidings owned by the sender or consignee. Some of these sidings also have restricted clearances. Enlarging clearances on railway property to permit larger wagons to be used is often not justified economically. It is at least within the power of the railway authorities to decide. They cannot control the lay-out of private sidings to the same degree. The 24½-ton capacity wagons and indeed some smaller ones are not acceptable in certain collieries and sidings, perhaps because they cannot clear the colliery screens or be handled by the tipping apparatus which many firms use for discharging loads.

Thirdly, there is the question of obtaining traffic in sufficiently large consignments to use the increased capacity. There is no gain if the operator changes from 21-ton to 24½-ton wagons but continues to load them with 21-ton loads.

The present fleet of mineral wagons is composed mainly of 16-ton-capacity vehicles but there are some smaller. There is also an increasing number of wagons with a capacity higher than 16 tons, including 24½-ton-capacity (normal maximum two-axle load) and 56-ton-capacity bogie vehicles.

Wagons which are to be unloaded by tipping do not need doors. As some apparatus which tips the wagons is not compatible with the wagon under-gear associated with the clasp-type vacuum brake, they may require to be fitted with disc brakes instead. Others may have side doors only, or end and side doors. Some have doors in the wagon floor, too (bottom doors), and some of these vehicles are fitted with hoppers to facilitate gravity discharge. Wagons may be specified for particular types of mineral traffic; e.g., ironstone, coke and so on.

The very high proportion of mineral-wagon journeys originating and terminating in private sidings brings a further problem in relation to coupling and uncoupling. Wagons with screw couplings can only be coupled and uncoupled by staff getting between the wagons, and certain organizations are not prepared for their staff to do this. On the other hand, the ordinary three-link couplings are too loose for express freight train speeds. In the absence of automatic couplings, the most satisfactory answer appears to be an " instanter " coupling which can be unhooked or hooked up by a shunting pole. An instanter coupling is a three-link coupling in which the middle link is an irregular triangle.

When it is placed in the short position (Plate 9) it is nearly, but not quite, as good as a screw coupling and is quite satisfactory for express freight train working. Apart from the three main groups of wagons—open, covered and mineral—there are a number of smaller groups. The main one is steel-carrying wagons.

Steel-carrying Wagons. A large proportion of railway revenue is derived from the carriage of freight for the iron and steel industry. From the operating point of view it is unfortunate that the mineral wagons which take the ore, the coal and coke, the limestone and the scrap into the steel factories are not suitable for conveying many of the end-products away. But they are far from suitable, as the heavy and sometimes bulky articles which are produced often demand special wagons. There is steel plate in varying thicknesses, girders, rails, bars, castings, tubes, pipes and so on. There is considerable variation in the size of these articles.

The fleet of wagons used to deal with this traffic includes long wagons for the conveyance of tubes and pipes and others for steel plate, including bogie plate wagons. There are also several different types of bolster wagons. A bolster is a raised transverse beam on which the load rests clear of the wagon floor. This facilitates loading and unloading. In view of the heavy and bulky nature of some steel traffics, it is not surprising that about a quarter of the steel-carrying wagons are bogie vehicles with capacities up to 42 tons.

Special Wagons. A number of types already reviewed have been designed for the carriage of specific traffics, but the word *Special* is reserved for wagons which are controlled individually; i.e., by the painted number on the wagon. They represent only a small proportion of the fleet and include wagons designed to carry plate glass, electricity transformers, machinery, motor-cars in two tiers and various other commodities. There is a case to be argued for the extension of this individual control to more wagons, particularly those that are designed for specific traffics, to enable a closer supervision to be kept on their movement.

In each of the groups, it has been shown, there is a confliction between the two main considerations—suitability for traffic and economy in operation. To provide the ideal wagon for each traffic demands more and more types. An increase in types tends to put up building costs because mass production methods cannot be employed to the same degree. Maintenance costs are also inflated mainly because increased numbers of spares have to be held. There is more shunting to be done. The operator finds it more difficult or even impossible to get back loads; i.e., movement under load in both directions. Naturally,

if the ratio of empty wagon haulage to loaded wagon haulage increases, operations become less profitable. Keeping wagons in continuous employment is also more difficult if they are capable of being used only for a limited range of traffics. A decline in production in the iron and steel industry may leave the railway with many steel-carrying wagons surplus to requirements. While these wagons are not employed they represent wasted capital investment, and provide a storage problem which may be costly to solve. But a decline in an industry using covered vans for their traffic, may be offset by an increased output and use of covered vans by another industry.

ROAD/RAIL VEHICLES

These vehicles are designed to dispense with the need for transfer between road and rail vehicles at each end of a rail journey. One type, known as a Roadrailer (Plate 8), is fitted with two pairs of wheels, one for road and one for rail, which can be raised or lowered in about two minutes by means of an air-operated mechanism. Each vehicle runs on only one pair of wheels at one end, the other end being articulated with the next vehicle. At the front of the train a special adaptor bogie is used for coupling to the locomotive. As the vehicle runs on one pair of wheels it cannot be shunted in marshalling yards. The terminal facilities required for the operation of a Roadrailer are very simple. They constitute (1) a siding, which may for convenience at intermediate stations be a loop, with the ground built up to track level; (2) a portable compressor delivering air at 90 lb. per sq. in.

UTILIZATION

How efficiently the fleet is used depends on (*a*) the number of loaded trips obtained in a given time, and (*b*) how well the capacity of the wagon is used on each trip.

Number of Loaded Trips. A fleet of wagons each doing one loaded trip in four days, could do the same work as a similar fleet twice the size doing one trip in eight days. This important measure of use is normally expressed as " Average round trip time." (See Chapter 15, page 244). It represents the interval between a wagon starting out on a loaded journey and starting out again on its next loaded journey. It includes: (1) transit time of first journey; (2) waiting to be unloaded after first journey; (3) being unloaded; (4) standing empty; (5) if there is no suitable traffic at destination point, being moved empty to a place where it is needed; (6) waiting loading; (7) being loaded; (8) waiting despatch.

Attention must be concentrated on speeding up the movement of

the wagon, both loaded and empty, accelerating the loading and unloading processes and eliminating the other factors if possible. If this is not possible, they should be reduced to a minimum. In Chapter 12 a number of proposals to reduce transit times are set out. Although this chapter relates to freight traffic, several of the points raised apply also to the transits of wagons containing mineral traffic and indeed to empty wagon transits. It must be emphasized that there is an urgency in moving mineral traffics and in moving empty wagons, in order to enable the railway at any time to make wagons available for loading at the time and place required, without employing a fleet of wagons which is too large in relation to the work to be done.

Reducing the time in loading and unloading at railway terminals is dealt with in Chapter 7. Wagon design, we have seen, may help or hinder rapid loading and unloading. On the N.E. Region 56-ton side-discharge hopper wagons fitted with power-operated doors are employed to carry iron ore from Tyne Dock to the Consett Ironworks. At Tyne Dock a train-load of wagons is simultaneously filled with ore from a line of overhead hoppers. On arrival at Consett the train-load of about 500-tons is discharged by the pneumatic operation of the doors, controlled from the locomotive. In this case the loading and unloading processes are completed in minutes. In consequence, these wagons are able to make several trips a day. Not all traffics lend themselves to such rapid loading and unloading procedures, but methods of reducing time on these operations are worthy of study.

How to reduce the time spent waiting unloading and loading is also dealt with in Chapter 7. The situation may be completely under the control of the railway operator, as with wagons which are to be unloaded by railway staff for delivery by railway vehicles. However, with loads originating or terminating in private sidings or with wagons being loaded or unloaded by customers on railway premises, his control is only indirect. He can influence the detention of the wagon by the trader, by persuasion and also by imposing penalty charges (demurrage) after a reasonable allowance of time has been permitted for loading or discharging the vehicle.

One of the advantages of rail wagons over road vehicles is that they can be detained more economically. Detention of a lorry involves detention of a motive-power unit as well as a carrying vehicle and often detention of the driver also. A railway wagon may be depreciated over a 30-year period or even more, whereas a lorry may have a life of only a third of that time. In consequence, the depreciation charges for a rail vehicle over a period of time may be a good deal less than for a lorry of similar capacity. The railways must exploit this advantage.

For example, it may be economical for them to provide sufficient empty wagons at a port to enable a ship to be discharged as rapidly as possible, thus obtaining traffic at a price with which the road haulier with his higher detention costs could not compete. The railway may have exploited small depreciation costs to a degree that has resulted in a freight rolling stock fleet which is too large. In any case, even if a policy of a large wagon fleet were the correct one when wagons were cheap, it is not necessarily the correct policy now. There seems to have been handed down from one generation of railway men to another a lack of economic respect for wagons. Some railway officers who would not countenance the detention under-load of a road trailer for more than a few hours, are quite unmoved at the detention of a wagon, twice as expensive as the trailer, for several days.

Of course, there is no reason why the railway should not permit customers to use wagons as warehouses, providing they are prepared to pay adequately for the privilege. One doubts whether many of them would be prepared to do this, as it is basically uneconomical to use a piece of equipment designed for movement merely as a storage unit.

One of the principles proposed in Chapter 1 stated that operating units in excess of requirements are costly and lead to inefficient operation. A wagon fleet which is too large is obviously costly and leads to inefficiency in various ways. It removes part of the incentive to move loaded wagons quickly to destination and to discharge them rapidly, which may result in extended transits. Congestion, the arch-enemy of efficient operation, is more likely to occur with a large fleet than with a smaller one. Having too many wagons also removes part of the incentive to load wagons to their capacity. With much goods traffic, loading the last few tons into a wagon is more difficult than loading the first few tons. As the goods have to be stacked higher and higher, an increasing amount of time and energy are expended. If a spare wagon is standing adjacent to one being loaded there is a temptation to spread the load over the two wagons. A slight advantage accrues at the sending point, i.e., quicker loading—thereby releasing staff for other duties, but the disadvantages are numerous. The reader is invited to work them out for himself. Therefore, careful regard must be paid to ensuring the fleet is not too large, at the same time taking advantage of the cheaper time costs of a rail vehicle as compared with a self-propelled road vehicle. This permits traders to load and unload at their convenience instead of at the convenience of the carrier, and places rail transport in an advantageous position.

Thinking of the principle relating to peak traffics, it would be folly to base the size of the fleet of a particular type of wagon on the peak

demands, particularly if they are of short duration. The capacity of units depends on how they are used. If the numbers of wagon, employed is based upon traffic requirements at reasonably busy times peaks can be met by special tactics. These could include overtime and week-end working to speed up movement and discharge. A temporary increase in demurrage rates at peak periods (which could be offset by reduced demurrage charges at slack times such as holiday periods) might help. There is also a point at which the operator must ask himself if it is desirable that he should meet the highest peaks at all.

Apart from movement peaks there are also storage peaks. One example is sugar-beet traffic. The factories for extracting the sugar and by-products open about October and close in the spring when the crop has been processed. They have been located strategically in the beet-growing areas. In consequence, most beet travels only short distances to the factory. In view of what has been written earlier about rail transport being most competitive over long distances, it is not surprising that most beet goes to the factories by road. However, the factories like to take in beet in rail wagons to provide themselves with a reservoir of material when road vehicles are not arriving, such as at week-ends, Christmas holidays and so on. Because of the short distances involved, the revenue per wagon trip is small, yet the detention of wagons is serious. Mineral wagons are normally used and it will be observed that the demands for wagons for beet coincides with the peak demands for the same type of wagon for coal movement. One must ensure that either the user pays an economic rate or else that wagons are deployed only on those activities which are profitable.

Similarly, there are peak demands for storage of coal in wagons. This is not so serious in the summer months when demand is small, and it does not coincide with peak-movement demands. Once the optimum size of the fleet has been decided on an economic basis, it is better that during slack periods wagons which cannot be found movement work should earn something. This may be done by standing under-load with stock coal instead of standing empty.

A method of continuing to grant traders latitude in loading and unloading rail vehicles to suit their own working arrangements, and at the same time to cut the size of the fleet, is needed. A demountable wagon body which the trader could load and unload in his own time, while the chassis was kept on the move with another load, might enable this to be achieved. Containers now in use partially achieve this aim, but they are subject to serious loading limitations.

Distribution Machinery. A factor in increasing the loaded trips a wagon makes is an efficient distribution system of wagons after they

have been unloaded. The aim is to get the right type of wagon available for loading at the place and time required. Certain wagons are in circuit working. These wagons are usually those designed or set aside for the conveyance of special traffics. They may be allocated to work between two points or to operate from a specific station. Instructions for disposal after unloading are normally stencilled on the wagon; i.e., " when empty, return to X Depot." But most wagons are available for general use at any point where they may be required.

The distribution system in operation at the time of writing has been subject to much criticism. It is worthwhile describing briefly how it works and its inherent disadvantages, before considering alternative methods. The basis of it is a Daily Freight Rolling Stock (F.R.S.) Return (see specimen on pages 54-55) compiled by all stations, depots and private sidings where wagons are loaded and unloaded. A small minority of wagons are not distributed through this machinery, including special wagons (previously referred to) which are controlled individually by their stencilled numbers.

On the Freight Rolling Stock Return the following information is recorded for each type of wagon and shows, among other things:

(1) Number on hand loaded.

(2) Number on hand loaded, plus any expected to arrive loaded, which it is estimated will be discharged during the day and therefore will be available for loading next day or distribution on the same or next day.

(3) Number on hand empty, which are not required for loading same day.

(4) Total required for loading on the following day.

From items 2, 3 and 4 may be calculated: (*a*) the number of wagons which need to be sent from other depots to fulfil the orders for the following day, or (*b*) the number of wagons surplus to requirements which are available for distribution to other points.

The return is a statement of the position at 10.00 a.m. in the morning, but you will notice that, in so far as it is a requisition, it is ordering wagons for the following day's use. If the wagons required have to be brought some distance, a certain amount of notice is required; but there is a case to argue that 10.00 a.m. is too early for an accurate assessment to be made of the morrow's needs and how far the station will be able to meet them from its own resources. The records of wagons on hand, loaded and empty should be accurate. An important contribution to the efficient use of rolling stock is to ensure the accuracy of these figures. If wagons are omitted from this count, there is a

B.R. 87240

BRITISH RAILWAYS.....REGION

TERMINAL No..... FORM A (SMALL)

TO BE USED WHEN TELEGRAPHING SECTION B.

Prefix Code time No. of words

Station and instructions from	Time received	Clerk
Station and instructions to	**Time forwarded**	**Clerk**

DAILY FREIGHT ROLLING STOCK RETURN

From ..... Station

Date..... 19....

SECTION A

STATEMENT OF WAGONS, SHEETS AND ROPES ON HAND, RECEIVED AND FORWARDED

TYPE OF STOCK (To be inserted)	Code	ON HAND at 10 a.m. yesterday			RECEIVED since 10 a.m. yesterday			FORWARDED since 10 a.m. yesterday			ON HAND at 10 a.m. today			Inwards Loaded Discharged	†
		Loaded (Inward & Outward)	Empty	Total	Loaded	Empty	Total	Loaded	Empty	Total	Loaded (Inward & Outward)	Empty	Total	Since 10 a.m. yesterday	
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
OPEN															
TOTAL—GROUP 1															
COVERED															

SECTION B

Code	Inward Loaded on hand at 10 a.m.	Total required for loading tomorrow	Empty on hand at 10 a.m. today available for immediate distribution or loading tomorrow	Inward Loaded on hand and expected to arrive anticipated to be available for loading next day or for distribution same day or next morning	Wanted additional for loading tomorrow	To spare
	L.	R.	E.	U.	W.	S.

TOTAL—GROUP 2		
STEEL CARRYING		
TOTAL—GROUP 3		
MINERAL		
TOTAL—GROUP 4		
CATTLE	Ox	
CATTLE V.B.	Ox-fit	
TOTAL—CATTLE		
SHEETS	Sheets	
Ropes	Ropes	

† For use as and when instructed.

§ To agree with line of entry—

NOTE:—Each twin set to be recorded as TWO vehicles.

BOGIE BOLSTER ANALYSIS

Group	L.	R.	E.	U.	W.	S.
A.						
B.						
C.						
D.						
§Total						

Signature.....

The return must, when compiled, be certified personally by the Goods Agent or Stationmaster.

potential waste. The omission of an odd wagon may not seem a serious matter at first thought. If this occurs at several hundred stations, however, the consequences are great. Under-declarations may result in time, effort and money being expended on meeting apparent shortages which do not really exist.

Items 2 and 4 are estimates. One cannot foretell precisely at 10.00 a.m. how many wagons will be unloaded in the day. Forecasts of the number of wagons required for loading next day may not always be accurate. A consignor may not send as much traffic as he anticipated, or he may get an order requiring immediate fulfilment which could not have been predicted. In consequence, the conclusions reached regarding wagons required or wagons surplus are only approximations. If the return were compiled later in the day it would be more factual and the need to make assumptions would be reduced.

A well meaning, but misguided local official with a parochial outlook may try to ensure that he will have sufficient wagons of all types to meet contingencies. This may be done by: (*a*) failing to declare wagons on hand loaded or empty; (*b*) not being realistic in his estimate of wagons that can be unloaded; (*c*) ordering more wagons than are really required for the following day's use.

This type of conduct is not conducive to the efficient use of freight rolling stock and may cause empties to be sent to places where they are not required. Unfortunately, it is likely to happen most when there is a brisk demand for wagons. It is desirable to: (*a*) arrange for occasional checks of wagons on hand against the daily return by a district official; (*b*) check the actual figures of inwards loaded wagons discharged against the forecasts, and ascertain the reasons for errors; (*c*) check the number of loaded wagons forwarded against the number of wagons ordered. This is expressed as a percentage on a weekly wagon return which each depot is also called upon to compile.

The information on the daily return is communicated promptly to the District F.R.S. Controller. As he receives the details he must:

(1) Equate the surplus and shortages between the various stations on the district. For example, if stations *A* and *B* each have a surplus of a particular type of wagon and *C* requires some, the wagons should be ordered from whichever is most convenient. Empty wagon mileage should be kept to a minimum, but the timing and adequacy of the service to move the stock is obviously an important consideration.

(2) Compile a summary of all the station returns in the district. The totals of this represent the district position for wagons. There is likely to be a shortage of certain types and a surplus of others.

This information is then passed to a Line or Regional F.R.S. Control who equate shortages and surpluses between districts in the same manner as the district control did between stations. Finally, an organization is needed to perform the same process between Regions. All empty wagons ordered to specific points should bear special "empty" labels showing the sending point, destination and date of despatch. Freight stock must not be obtained from or sent to other stations, nor taken from trains without authority.

The need for definite flows of empty wagons will be apparent, varying with seasonal traffics. Two examples are: (*a*) empty coal wagons from non-mining areas to mining areas; (*b*) empty steel-carrying wagons to the steel works. A programme of trains to meet regular flows of empties should be scheduled in the Working Timetable. Substantial changes in the volume and direction of empty wagon movement will occur nevertheless, and an efficient organization to control it is essential. There must be a general realization that the movement of empty wagons often merits equal importance with, and occasionally greater importance than, the movement of loaded wagons. Cancellations of empty wagon trains, or appropriation of them for the conveyance of loaded traffic should not be permitted unless all considerations have been properly weighed.

To keep down the cost of moving empty wagons from areas which make a surplus to areas which need them, advantage should be taken of any spare capacity on trains scheduled for loaded traffic. These trains may be made up to the locomotive capacity with empty wagons. This may also have the advantage of being self-balancing. If there are less loaded wagons entering the receiving area and, therefore, less wagons available for reloading after discharge, the number of empties coming in will increase.

At times of heavy demand for a particular type of wagon the interests of different stations, different districts and different regions have to be weighed and a system of priorities established. A number of factors have to be taken into account, including the importance of the customers or the traffics concerned. One elementary item from the operating viewpoint is to ascertain how well a station, district or region is attempting to solve its alleged shortage of a particular type of wagon without calling for the movement of empty wagons from elsewhere. How many loaded wagons of this type have they got and how quickly are they unloading them? Please refer to Chapter 15, page 244 for details of the statistics employed to investigate this. (See Terminal Discharge Time). To meet a request for empty wagons to be sent to the depot is not necessarily the correct solution. It may

be possible to find means of speeding up the discharge of wagons under-load to meet the need for empties.

There is another useful figure which takes into account the efficiency of the whole of station working in dealing with freight rolling stock. This is Terminal User Time (Chapter 15, page 244).

Not all wagons are in stations, depots and private sidings at 10.0 a.m. when the daily count of wagons is made. Some are in marshalling yards, some are on trains and some in wagon repair sidings. If stock is to be distributed efficiently these must also be taken into account. Arrangements must be made for marshalling yards to report details of empties on hand to the distributor, who also should be aware of the numbers of empty wagons of various types on all trains.

In addition to the disadvantages of the present distribution system which have been mentioned previously, there are a number of others, including:

(1) Empty wagons on hand required for loading the *same* day are not declared on Section B of the daily return (which is the part the distributor works from), because they will not be available for loading at that station on the *next* day. When demand is brisk more wagons are being loaded out on the same day, therefore less wagons are being declared to the distributor. At these times when he should be exercising the greatest skill in distributing effectively, less wagons than usual are being declared, and his knowledge of the actual location of wagons is inadequate.

(2) Wagons in transit under-load, apart from the few declared on the daily return as expected to be received and unloaded, are not taken into account. Yet a considerable number of these wagons should be unloaded and available for re-loading on the morrow.

(3) Provision is not made in the distribution instructions for empty wagons in transit to be shown on the returns. However, an efficient distributor will ensure that he has this important information before making decisions on distribution. This necessitates a record being kept of the individual types of empty wagons being conveyed by each train.

To sum up, the distribution machinery outlined above operates on an inadequate knowledge of the whereabouts of the wagons which are being controlled. The totals of the daily returns represent only a small proportion of the wagon fleet. Until the distributor knows more precisely the dispersal of the wagons, it will be difficult to be more efficient. Later on in the chapters on Control, on Freight Train Services and on Freight Traffic Transits, it will be shown that for other purposes

also a more detailed knowledge of wagon movements is required. A more satisfactory arrangement would be a system of Continuous Progress Control, but if adopted, the cost of operating the distribution system would increase.

Continuous Progress Control is based on maintaining a continuous record of all wagons at all times instead of relying on a once-daily declaration of wagon stocks on hand as does the system previously described. In addition it takes into account all wagons in transit as well as those on hand in terminals and sidings.

For the purpose of Continuous Progress Control the railway is divided up into small areas of responsibility. It is necessary that all places which are able to accommodate wagons for any purpose, should be included in such an area and be under the supervision of a station master, yard master or other official. In the District F.R.S. Control Office a continuous record is maintained for each of these areas. This record, known as a Continuity Sheet, shows the number of wagons of each type on hand and their state; i.e., whether loaded, empty, waiting repairs etc. When a train commences its journey from a point within the area its loading is advised to the Control Office by telephone. The loading advice, which is known as a Train Consist Record, shows the type, state and destination of each wagon or group of wagons on the train. The F.R.S. Controller subtracts the wagons that have just left from the totals shown on the Continuity Sheet for that area. Meanwhile, the wagons are recorded as being in transit and, when necessary, details are passed to another District F.R.S. Control Office. As the wagons are detached at points *en route* or at the destination, a suitable addition is made to the totals concerned, for the area of responsibility in which the wagons have arrived. This procedure enables an accurate record to be kept in the Control at all times of the number of wagons of each type on hand at all points within the district, and also of all wagons in transit. By adding these together the district totals may be calculated at any time when required.

Apart from a change of location, wagons may also undergo a change of state. Wagons that were unloaded are loaded and vice versa; wagons that were out of use, in need of repair, are repaired and so on. In order that the F.R.S. Control may keep informed of the state of the wagons in each area, it is necessary to require each point to submit returns of wagons on hand (a Periodic F.R.S. Return) according to type and state at suitable intervals. The frequency of submission required varies according to circumstances. For example, in a marshalling yard few wagons are normally loaded or unloaded; therefore less frequent returns are required than from a freight terminal.

When these returns are received at the F.R.S. Control the Continuity Sheet must be brought up to date to take into account the changed state of the various types on hand. However, the total number of wagons of each type on hand declared should equal the totals already recorded in the F.R.S. Control. This provides a check on the accuracy of the figures and serious discrepancies should be investigated immediately. This check enables any under-declarations to be detected at once.

The Periodic F.R.S. Return also incorporates the estimated requirements for the following day for the various types of wagons for loading purposes, and shows the net wanted or surplus figures. The F.R.S. Control equate the shortages and surpluses by the same methods as those which are employed at present, and which have been previously described.

Keeping the continuity sheets up to date involves the employment of more staff than are at present employed in District F.R.S. Controls. Additional expense would also arise in the provision of desk calculators. In order that the F.R.S. position in the whole district may be seen at a glance it may also be desirable for the current position to be displayed on progress boards. One, a " Static " board showing the number of wagons on hand at each wagon handling point by type and state. The other, a " Transit " board depicting the loading of each train. If boards are employed, additional staff will also be required to revise them with the information coming in. The manual processing of the information is the main cause of the increased staff costs but the development of electronic processing is feasible. This would lessen the staff costs on Continuous Progress Control.

A development of Continuous Progress Control, which described the individual wagon numbers instead of merely the types of wagons, could provide the Advance Traffic Information discussed in Chapter 12.

Summary of Attributes of Distribution Machinery. The essence of efficient distribution is:

(*a*) Comprehensive and accurate figures of the location of wagons.

(*b*) Accurate estimates of wagons under-load and under repair which can be released for loading or distribution.

(*c*) Accurate forecasting of the number of wagons required for loading.

(*d*) Prompt communication of information.

(*e*) Giving prompt and correct distribution instructions.

(*f*) Prompt carrying out of the instructions.

(*g*) An adequate train service (including engines and crews for special trains) to enable distribution instructions to be executed swiftly.

Avoiding Cross-haulage. One factor which often retards the meeting of orders for particular types of wagons, is an inadequate number of sorting sidings in marshalling yards in which to segregate the different types. Attempts should be made to avoid this as it leads to the despatch to other yards of train loads of " mixed " empties for sorting purposes. Where this happens one sometimes finds that, after sorting, particular types have to be sent back to the environs of the marshalling yard from which the mixed empties were sent. When empties are being sent in both directions in this manner, it is referred to as *cross-haulage.* Efficient operation demands that cross-haulage should be eliminated if at all possible.

Every effort should also be made to avoid cross-haulage of different types of empties, where with a little improvisation the incoming empties may be used to convey return loads. For example, open wagons may be used and the loads sheeted rather than empty covered vans should be imported. An example which comes to mind concerned an agricultural area which received manufactured goods but forwarded mainly agricultural produce, in particular, vegetables. In consequence it was a railway district which received more covered vans than it forwarded and there was a regular exodus of empty vans back to the industrial areas. The local farmers had demanded cattle vans for many years for the conveyance of certain vegetables because such wagons give maximum ventilation to the produce.

To meet this demand empty cattle wagons had to be sent in. This often resulted in train loads of empty vans travelling up passing train loads of empty cattle wagons going down. Eventually a persistent railway officer managed to prove to the farmers that their produce could be conveyed equally well in covered vans, which were ventilated. The outcome was back-loading for many of the incoming vans and the elimination of empty running in both directions. Economy in locomotives, men, line capacity etc., as well as in freight rolling stock resulted. This is a further example showing that less specialization in vehicles can result in more efficient operation.

So far, consideration has been given to improving utilization by reducing time in terminals, by speeding up transits of loaded and empty wagons and by the most effective use of the distribution machinery. One of numerous other incidental causes which results in poor utilization is the five-day working week in industry. Wagons received after unloading has finished on Friday are usually detained under-load until Monday. This situation operates to the disadvantage of the railway with steel-carrying wagons even more than with other types. While the consignees unload only on five days, the steel manu-

facturers require a supply of empty wagons for loading on seven days. In addition, the special nature of steel-carrying wagons frequently necessitates an empty journey after each loaded journey of a similar distance. Poor utilization of this section of the fleet is the consequence of these factors.

Wagons Under Repair. The main considerations with wagon repair sidings are: (*a*) to reduce the time spent in the sidings to a minimum; (*b*) to arrange the wagon maintenance programme to provide for maximum work being done on a particular type when demand is slack, and to detain the minimum number for repairs when peak traffics are offering; (*c*) to have the distributor informed of the number and types of wagons, that will be despatched from the repair siding daily after repairs, in order that he can arrange their immediate and most efficient absorption into traffic.

Incidentally, wagons that have been stopped for repairs at stations, etc., are excluded from the present daily F.R.S. return. An arrangement for the distributor to be made aware of the location, numbers and types of these, also when they are likely to be repaired and released for traffic purposes, is beneficial.

LOADING TO CAPACITY

The amount of work which can be obtained from a vehicle depends not only on how many trips a wagon makes in a certain time, but also on how much it conveys per trip. A fleet of wagons conveying an average of 10 tons per journey could perform twice as much work as a similar fleet carrying five tons per journey. With certain traffics which are light in relation to their bulk the space capacity of the wagon is fully taxed long before the maximum permitted loading weight has been reached. Similarly, certain consignors offer traffic in part-wagon loads which cannot be conveniently combined with traffic from other senders, and this leads to waste of wagon space and loading capacity. The important consideration is that a large ratio of operating costs normally relates to handling the wagon load. Charges should, therefore, favour traffics which can be loaded to the capacity of the wagon and which are offered in full wagon loads. Higher charges should be made in other cases to ensure that increased operating costs per ton are offset.

Apart from encouraging good wagon loads by a sensible charging system, other action can be taken. Concentration of freight traffic at fewer stations, discussed in Chapter 7, is one measure. If stations *A*, *B* and *C*, in close proximity to one another, each forward two tons per day to station *Z*, it takes three wagons each day. Concentrating

the traffic from *B* and *C* on *A* may enable all the traffic to be transported in one wagon. Various other improvements in wagon utilization are to be gained from concentration of freight traffic; these include quicker transits and better chances of obtaining back loads.

Effective supervision also has an important part to play. It has already been pointed out that loading a wagon to capacity involves a little more effort. Similarly, if wagons are received with composite loads, i.e., including traffic for a station or stations other than the destination station, the easy solution is to re-address the wagon, having extracted one's own traffic. To place the wagon at the appropriate site in the yard for making up with originating traffic involves extra shunting. Wagons are sometimes re-forwarded with very small loads for this reason. This suggests that resorting to composite loading should only be done after all alternatives have been examined.

Consider for a moment traffic travelling from depot *Z* to depots *A*, *B* and *C*, which are fairly close to one another but have not been concentrated at one railhead. Depot *Z* has one ton for each destination. By loading the traffic in one vehicle, it appears—at first—to be the most economical method so far as wagon costs are concerned. On the day after loading the wagon reaches *A* who extracts his traffic and re-consigns the wagon to *B*. The train service may be such that the wagon does not arrive at *B* until the second day and at *C* until the third day. The journey has, therefore, cost three wagon-days. To have sent separate wagons to *A*, *B* and *C* would also have cost three wagon-days if each was received overnight. For equal wagon costs, using the second method, overnight transits have been given, compared with two- and three-day transits with the first method. There are other matters to be taken into account such as train-loading considerations.

Another method of achieving good wagon loads, and which has undesirable features, is holding traffic over until a good load has accumulated. Two tons of traffic on Monday and the same on Tuesday held over and combined with Wednesday's traffic may enable a well-loaded wagon to be forwarded, but this does not justify the resulting transit delays. If the traffic has been held in a wagon, then no economy in wagon costs will have been made. If the traders can be persuaded to forward traffic to particular destinations on certain days, this may well improve wagon loadings without detriment to transits.

It is interesting to note that mineral wagons which have a fairly good load but a poor average round-trip time, normally produce better economic results than covered vans which have a much quicker round-trip time but a low average load.

Finally, it is necessary to say that although wagons should be loaded

to capacity, the specified weight limit should not be exceeded. Going beyond the limit is likely to lead to overheating of the axle boxes, and may result in a serious accident. The slogan should be "To capacity not to excess."

F.R.S. COUPLINGS

The main types of coupling are as follows.

Screw Couplings. After this type of coupling has been placed over the draw-bar hook of the adjacent wagon, the screw is adjusted to bring the buffers firmly together. This prevents oscillation in running and prohibits the buffers being separated by any change of gradient or by the starting of a train. The disadvantage of this coupling is that men have to go between wagons to couple and uncouple.

Instanter Couplings. Many wagons start from (or arrive at) private sidings. Some traders will not agree to their staff going between wagons to couple or uncouple, and therefore it is necessary to employ an instanter coupling (Plate 9) which can be unhooked or hooked up by a shunting pole. When placed in the short position it gives a close coupling which is nearly, but not quite, as good as a screw coupling.

Three-link Couplings. These are the simplest type of coupling, which can easily be manipulated by a shunting pole but which only couple wagons loosely, and are not, therefore, satisfactory for the faster speeds.

Automatic Couplings. These engage automatically when wagons buffer up to give a close coupling. As they incorporate the vacuum pipe, no manual action is required at all in coupling (see Plate 10). Uncoupling is done by the switching of a lever. They are obviously the most satisfactory type but at the time of writing their additional cost has prevented their introduction on a wide scale.

SUMMARY

1. *Respect wagons—They're expensive.*
2. *The capacity of a wagon fleet is not fixed—It depends how you use it.*
3. *Specialization in design increases costs and conflicts with good utilization.*
4. *High-capacity wagons reduce operating costs.*
5. *Quick transits mean less wagons.*
6. *Deal with peaks by more intensive use of wagons.*
7. *Effective distribution must consider all wagons.*
8. *Reduce empty haulage.*
9. *Keep wagons moving—Load them to capacity.*

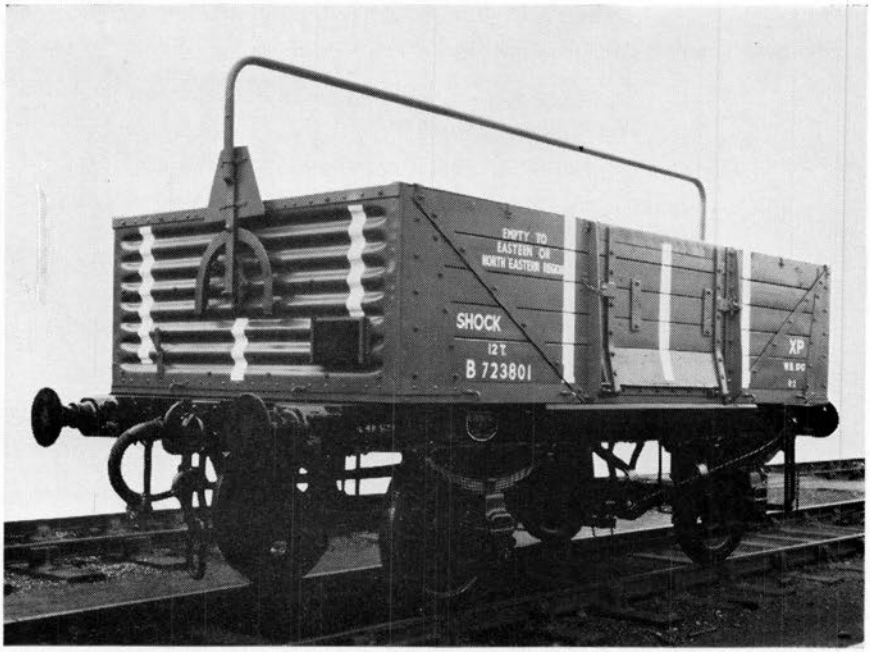


PLATE 5. *Open high-sided goods wagon fitted with shock-absorbing equipment. The painted white vertical lines on " shock " vehicles enable them to be readily identified. Note the sheet support bar.*

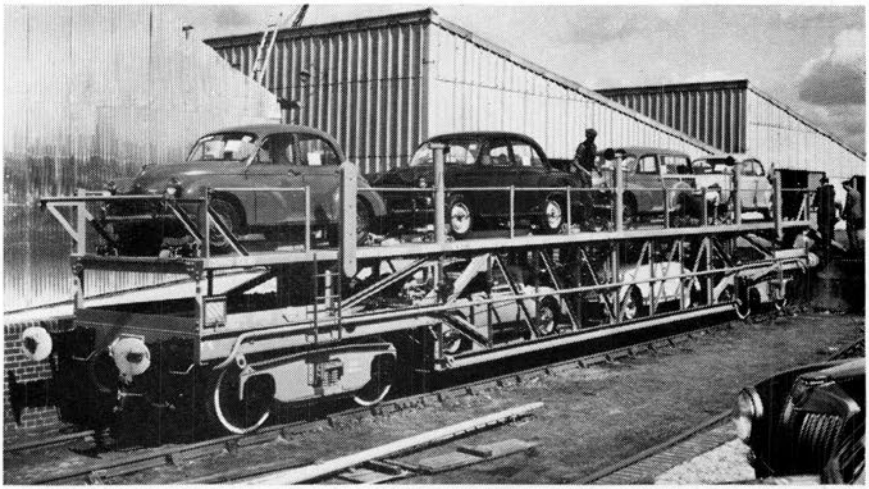


PLATE 6. *Two-decker car carrier wagon. The two cars on the bottom deck are positioned by a two-platform lift.*

PLATE 7. *The wide doors of the specially designed pallet van allow easy access for stacking pallets with the aid of mechanical handling equipment.*

PLATE 8. *Roadrailer in use as a semi-trailer with rail wheels retracted.*

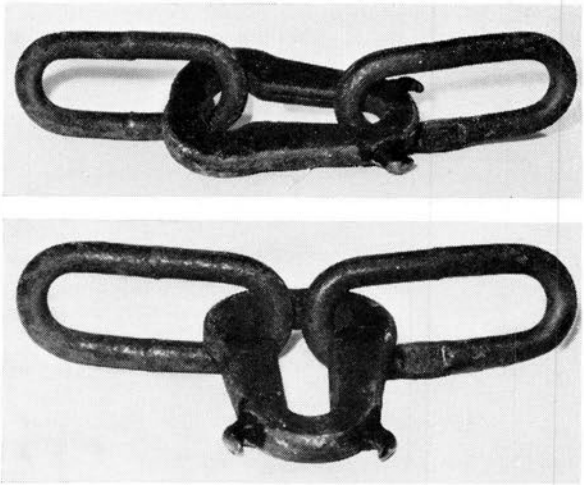


PLATE 9. *An instanter coupling. In the long position (upper) the coupling can easily be hooked or unhooked with a pole. When the centre link is manipulated to the short position (lower) close coupling of the wagons is secured.*

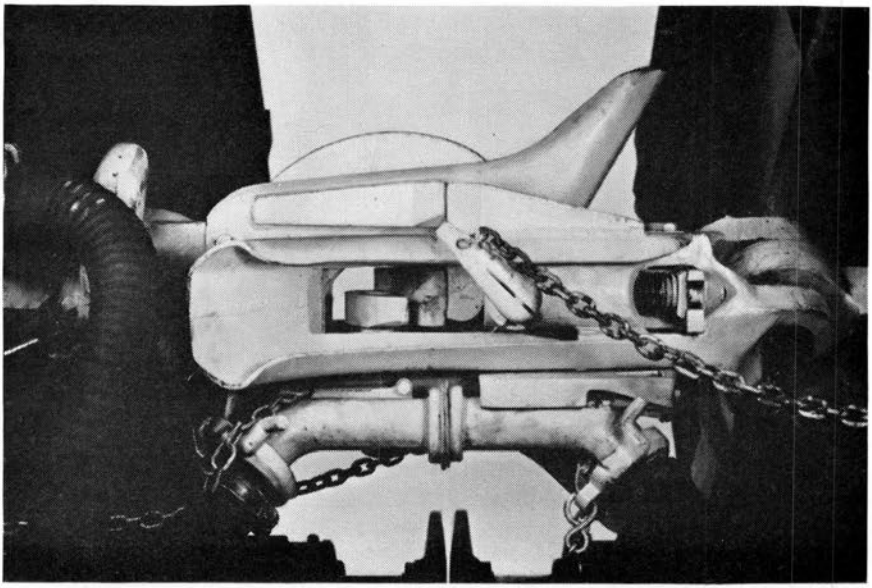


PLATE 10. *An automatic coupling showing the unit coupled with the vacuum-brake hose securely connected. The coupler will engage and lock under a wide range of conditions of track curvature and gradient. This coupling is compatible with all existing stock and interchangeable with other couplings without modifications to the wagons.*

PLATE 11. *Suburban electric multiple-unit stock used by the Scottish Region.*

PLATE 12. *Suburban diesel multiple-unit stock used by the London Midland Region.*

CHAPTER 4

Coaching Rolling Stock

As with wagons, the number of coaches required to do a certain amount of work depends on (*a*) the number and length of trips performed during a period of time; (*b*) the load carried. The measurement of work applied in Great Britain, which takes both these factors into account, is the passenger-mile. This is a similar figure to the ton mile mentioned in Chapter 1.

The French Railways reduced their fleet of passenger-carrying vehicles by half between 1939 and 1960. This was achieved by improving the passenger kilometres per vehicle by nearly 200 per cent during that time. It is a striking example of the principle that the capacity of an operating unit depends on how it is used. British Railways have not made such progress, but with a closer adherence to the principles of operation and with an increasing proportion of the fleet represented by multiple-unit vehicles, one would hope to see a substantial improvement in utilization.

Multiple-unit stock has the power unit incorporated in some of the passenger vehicles (Plate 12) and the power is distributed throughout the train. There are driving compartments at each end of a set of vehicles. Other stock is hauled by a separate locomotive. Methods of increasing the utilization of locomotive-hauled stock will be outlined later. It is sufficient to note at this stage that the railway in Great Britain lags behind many European countries in the amount of useful work performed by coaching rolling stock (C.R.S.), and there is room for improvement. If better utilization is brought about the result should be a reduction in the costs for the provision of passenger coaches.

In order to get the best operating results it is necessary to begin with the question of design and to establish how many types of vehicle are needed. The design considerations are (*a*) suitability for traffic; (*b*) economy in operation.

SUITABILITY FOR TRAFFIC

Passenger-carrying Vehicles

Fortunately, the passenger cargo is more homogeneous than the freight. With a freight cargo the transport operator has to be prepared for solids and liquids, packed or unpacked freight, in consign-

ments from a few pounds to several hundred tons, and of infinite variety. With passengers the variations which concern the operator more are:

(*a*) The degree of comfort required.
(*b*) How much the passenger is prepared to pay.
(*c*) Whether the travellers are making long or short journeys.
(*d*) Ancillary services such as meals required during the journey.
(*e*) If luggage is also to be transported, and if so, how much.

These items are interdependent. The short-distance passenger may not demand the same comfort which he would want on a longer journey. He is not likely to want a meal, a sleeping compartment or much luggage space. One effect of varying demands is the provision of different classes of travel—Pullman coach, 1st class, 2nd class, sleeping cars. The greater the comfort provided, the higher coaching-stock costs tend to become. Two important considerations are the willingness of the passenger to pay more for increased comfort, and the comfort that is available to him by competitive services. As far as the latter is concerned, it is important that the railway should be one step ahead all the time.

Suitability for traffic goes beyond merely providing for the comforts of the users of railway carriages. The design must take into account the operational needs of the passenger as well. Most commuters are concerned primarily with getting to and from work as quickly as possible at the cheapest rate. This can only be achieved by vehicles with a high capacity which give facilities for rapid loading and unloading. This involves providing a large number of doors or very wide doors. Such vehicles would not be suitable for long-distance work because many doors increase draughts, thereby reducing comfort levels, and wide doors reduce the number of seats which can be provided.

Vehicle Weight. Most passengers want a fast journey at the least cost. One disturbing feature of the design of coaching rolling stock is the amount of tare weight which the operator is required to move per passenger. This obviously affects the speed at which the passenger can be carried, and if this is overcome by the provision of more power the cost of transporting him increases. The principal items which contribute to a high tare weight are:

(1) Steel bogies and frames.
(2) Heavy buck-eye couplings are often fitted.
(3) Higher standards of comfort tend to reduce the number of seats per vehicle.

(4) The provision of corridors, lavatories, restaurants and buffet cars, sleeping compartments, etc., reduces still further the number of passengers per vehicle and per train.

Steel frames and buck-eye automatic couplings have made an important contribution to the safety of passengers. Train accidents are rare. On the few occasions when they occur the passenger receives protection from these two features—the frame reduces buckling and the coupling decreases the chances of overturning. However, because of high tare weight ratio, designers of coaches should constantly be striving to reduce the weight, without sacrificing safety. Vehicles being required to share a common bogie (articulation) is one method. The disadvantages of articulation include less flexibility in making up train loads. In addition, when one vehicle needs repairs more than one may need to be taken out of service. The use of light alloys such as aluminium for coach body work is another method of reducing the weight of vehicles. Its use may effect a reduction of several tons per vehicle as compared with steel.

Compartment or Open Stock. The main divisions in the types of coaching stock are between those that are locomotive-hauled and multiple-unit stock, which may be diesel or electric. A substantial proportion of the vehicles have gangways which permit access from one vehicle to the next. Vehicles may have first-class seats only, second-class seats only or a combination of the two. The last mentioned are normally called " composites." Some vehicles have open saloons, others have compartments. On suburban trains compartment stock has a high seating capacity. This is achieved by having narrow compartments, and no corridors. In these circumstances seating of six passengers a side, i.e. 12 per compartment, can be achieved. If there are 10 such compartments, a vehicle can seat 120 passengers. A train load of nine such vehicles, allowing for brakes and driving compartments, can convey over 1,000 passengers seated.

Contrast this with the number of road vehicles required to carry the same number of passengers, and the advantage of railways for dealing with suburban traffic will be apparent. An arrangement which provides an equal number of doors but also a centre corridor sacrifices a number of seats. The advantage to be derived is quicker loading at stations, as passengers do not delay the train by trying to find a suitable compartment. They are prepared to enter anywhere and walk through the train while it is in motion. Compartment stock for main-line purposes has wider compartments (see Plate 13), and the number per vehicle is more likely to be seven or eight. Apart from this effect of wider compartments, the number of them per coach is further reduced by trans-

verse corridors and the space occupied by lavatories. These items are important from the comfort point of view, but combined with a lower compartment capacity they drastically reduce the number of seats per vehicle.

The most common second-class-compartment vehicle has seats for 48 people, and first-class only 42. The vehicles weigh over 30 tons, so the dead weight per passenger is very high. Add to this the weight of restaurant cars, kitchen cars, brake vans etc., and it will be seen that the locomotive is often pulling about one ton for every seat. If half the seats are empty, it is about two tons per passenger! On trains of sleeping cars the position is still worse.

The low seating capacity of main-line compartment stock presents operating problems. To achieve high speeds it is desirable not to have too many vehicles per train, and yet it is necessary to supply sufficient seats for all passengers. This has led to the substitution of open vehicles for compartment vehicles for second-class travel on many well-patronized trains. The open second-class vehicle normally has 64 seats, which represents a gain of 16 seats per coach (see Plate 15).

Passenger surveys sometimes show that a majority of travellers prefer compartment-type stock. Other observations of the use of trains consisting partly of open stock and partly of compartment stock show that more people tend to enter the open vehicles. But whatever the true preferences are, the availability of 16 extra seats per vehicle (often over 100 seats per train) cannot be ignored. One thing is certain, there is a preference for a seat rather than having to stand.

In addition there are certain circumstances, particularly with party travel, when open vehicles are specifically demanded. In view of the wider utility, the better seating capacity, the easier cleaning and the reduced susceptibility to malicious damage of open vehicles, there appears to be good reason to concentrate on building this type for second-class main-line work. If the first-class passenger prefers a compartment, the 50 per cent higher fare paid should compensate the operator for providing it.

On suburban services open vehicles are normally associated with pneumatically operated double sliding doors controlled by the guard. Because of the width of the doors and because of the longitudinal corridors, the seating capacity is small compared with compartment suburban stock but there is more room for standing. Thus the number of passengers which can be conveyed is greater, the human frame being more compact in a standing position. When it is necessary for passengers to stand, it is less uncomfortable in an open vehicle than in a compartment vehicle. In planning a suburban service, the operator must

decide whether he wishes to cater for a large seating capacity or a large standing capacity. If the majority of passengers are going short distances the latter might be preferable. The pneumatic door has some operating advantages, including greater safety. The main drawback is that a failure of the door-operating mechanism puts the train out of use until the defect is repaired. To avoid unnecessary loss of heat at stations where the number of passengers joining and alighting is small, the opening of pneumatic doors should be done as necessary by passengers, subject to the operation of a release mechanism by the guard.

Train Sets

Coaching-stock vehicles may be dealt with individually, or where it is more convenient may be grouped into sets of two, three or more vehicles. This simplifies distribution and reduces shunting. Maintenance must be arranged on a set basis. If this is done, the only time it is necessary for the sets to be split is when one of the vehicles comprising the set requires special repairs.

Non-passenger-carrying Vehicles

Not all coaching-stock vehicles are passenger-carrying. Where there are considerable quantities of parcels etc., to be conveyed, the brake compartment in a passenger coach may not be adequate. There are some separate brake vans, therefore, also other vehicles for the conveyance of cars, parcels, horses and other commodities that travel by passenger-train service. The fleet includes kitchen cars and Post Office sorting vans.

Company-owned Vehicles

All the above-mentioned vehicles are railway-owned but there are also vehicles owned by the Pullman Car Company (Plate 14) and by Wagon-Lits, which are authorized to work on British Railways.

ECONOMY IN OPERATION

Economy in operation depends on: (1) initial cost; (2) annual charges for repairs and depreciation; (3) how much work the vehicle performs. As with freight vehicles the trend has been for initial costs to rise. The need to provide a safer and a more comfortable vehicle naturally produces this result, apart from general rises in prices. Air conditioning, double glazed windows, adjustable seats and so on inflate initial costs. The life of modern vehicles may prove to be a good deal shorter than those they are replacing. Obsolescence is likely to become a bigger feature and, in any case, vehicles constructed of light alloys

may be worn out more quickly than those with steel bodies. Therefore, the prospect is that depreciation costs will be higher, thereby inflating annual charges. It is only to be expected that depreciation and maintenance costs, as well as initial costs, are considerably higher for multiple-unit stock than for locomotive-hauled stock. Against this there is a saving on locomotive costs to be set.

Effect of Peaks

There is no reason why these higher costs should be translated into higher costs per passenger mile. This is within the power of the operator to regulate. It is a problem of utilization. The biggest single opposing factor to the efficient use of coaching stock is the peaks. The peaks operate in two ways. First there are the daily peaks as people travel to and from work, secondly, there are the seasonal peaks, Christmas, Easter, summer holidays and so on. The commuter compressed with over 1,000 others into a peak-hour train can be forgiven for thinking that transport of this kind is a profitable business. If he knew that the coaching stock (possibly multiple-unit stock worth many thousands of pounds) stood idle throughout Saturday and Sunday and over 20 out of the 24 hours on the other days in order to be available for this service, some doubt might be created in his mind. It has already been mentioned that operating units other than coaching stock are similarly affected. The coaches that are kept in traffic during the off-peak present a slightly better picture, but often with them less than 25 per cent of seats are occupied throughout the day.

So far as the seasonal peaks are concerned, please recall the example given in Chapter 1, when it was shown that stock used only on a few Saturdays in the summer could cost 100 times as much per passenger conveyed as stock in regular use. You may remember it was stated there that time-costs are the main factor with coaches. Maintenance is performed mainly on a time basis not on a mileage basis. Therefore increased mileage does not bring about appreciable increases in coaching-stock costs.

In planning the use of coaching stock one must try at least to maintain movement in the peak periods. Quick turn-rounds at stations are most important, and this is easier to achieve with multiple-unit stock. Cleaning, maintenance and fuelling must be performed outside the daily peaks as far as possible. A certain amount of cleaning and refuelling is probably inevitable during the seasonal peaks but it should be kept to a minimum.

In view of what has been said about some coaches working for only a few peak week-ends in the summer, it is particularly unfortunate that

at these week-ends some vehicles do only one or two trips. This is brought about by the greatest demand being on a Saturday, and because most people do not wish to start too early, neither arrive too late.

It is worth while to make efforts to spread this peak. Inducements to travel on a Friday, Saturday afternoon or evening, or Sunday, if sufficiently attractive to be effective, permit reductions to be made in the number of vehicles employed. The reduction will be in vehicles which are the least used and therefore the most expensive to operate. Cheap fares are one inducement. Sometimes compulsion is used in the form of regulation tickets. Passengers are required to obtain a regulation ticket as authority to travel on a particular train. After all the regulation tickets have been taken up for Saturday morning departures, intending passengers are obliged to travel at some other time. The main compensation for the passengers is that they are assured of seats on the train for which they succeed in getting tickets.

Carriage Workings

It is possible to plan the use of some passenger rolling stock in advance to a greater degree than can be done with freight rolling stock. The plans are set out in various forms and are known as carriage workings, carriage rosters, carriage diagrams, multiple-unit diagrams, etc. They should be prepared concurrently with the drawing up of a passenger train scheme or time-table. If it is left until the time-table of trains is completed, some of the resultant carriage workings may be inefficient. This inflates costs and leads to uneconomic working. In deciding the frequency of a new service it is not easy to establish at precisely what intervals trains should be run. No one can forecast with any accuracy how many more passengers will be attracted by a train service at say 15-minute intervals instead of 20-minute intervals. What can be established in advance is the interval which will permit the maximum use to be made of the coaching stock and other operating units. It is sensible, therefore, to base the plan on intensive utilization of equipment and staff, and to select an interval founded on this, which is approximately in line with the public demand.

One cannot, of course, look at the question of utilization of coaching stock in isolation. If an intensive service is planned to make good use of the stock, this may give the cheapest coaching-stock costs. To work the service, locomotives may be needed, fuel will be consumed, train crews employed and line capacity used up. Therefore, there must be sufficient potential traffic to meet, at least, these costs and also one must be satisfied that line-occupation problems are not created and freight

services are not retarded. If these things happen, the economies made on coaching stock may be dissipated in other directions. Remember the principle of the interdependence of operating units. However, assuming the potential demand is satisfactory and there are no line-occupation problems, it would be wrong to take an arbitrary decision that a service every X minutes is needed and to find out afterwards that this will involve the multiple-units or coaches standing an unnecessarily long time at the terminal after each trip.

Usually, however, regular interval services result in better utilization of coaching rolling stock than do the irregular type of services based on customers' alleged needs. An investigation into the latter service and adjustment of it to provide for better use of coaches, etc., can also prove profitable. One reason for this is that the so-called customers' needs are sometimes based on the demands of a persistent individual or a vociferous minority. (Please refer to Chapter 9 regarding more scientific methods of assessing the true wishes of the users.) The existing timings may not be in accordance with the wishes of the majority, and even if they are it does not necessarily pay the operator to meet them.

EXAMPLE. A train may be scheduled to depart at 5.45 p.m. and another to arrive at 5.45 p.m. By adjusting the incoming train to arrive a few minutes earlier, or the outgoing train to depart a few minutes later, the same coaches might form both trains. This would enable the following economies to be made:

(1) The train service could be worked by fewer vehicles.

(2) The empty stock trains required to bring coaches for the outgoing train and to remove the coaches of the incoming train could be eliminated.

(3) Cleaning costs could be reduced.

(4) Reduced platform occupation.

Item 2 is important in saving locomotives, train crews and line occupation.

The foregoing example illustrates that if incoming trains are used to form outgoing services not only is better utilization of coaches achieved but other advantages accrue as well. It cannot always be done because the incoming coaches may not be suitable. One encounters here the same kind of difficulty seen with freight rolling-stock—that specialization in vehicle design reduces the possibility of achieving high utilization. If an incoming train consists of main-line coaches it cannot normally be used to form a suburban train. If it is a sleeping-car service arriving in the morning, it will almost certainly require to be hauled empty to the carriage sidings, later to return to form an evening departure. Throughout the day, sleeping cars stand idle. During the night when the sleeping cars are working, most of the remainder of the fleet is standing idle. It is apparent that a better utilization would be

obtained by employing convertible coaching stock which could provide sleeping berths by night and seats during the day. The higher initial costs would be more than offset by the increased use which would be facilitated.

Standard Formations

In establishing what is a suitable train for a quick turn-round, it may be agreed that the stock is of the right group (main-line or suburban) but the formation is not what is required. The incoming train may need more first-class seats or more brake accommodation than the outgoing train. Because the advantages of direct turn-round are so important, it is worth while to plan a standard formation which will suit the maximum number of trains in a certain area. This will help in getting the fastest turn-rounds at the various termini in the area. An arriving train may be scheduled to form the first available departure regardless of destination, with benefit to coaching-stock costs and to platform availability. An additional advantage is the greater flexibility of trains when the scheduled arrangements break down for any reason.

The standard formation will not be ideal for all the services it covers but, if it meets requirements reasonably, it may be wise to adopt it. One example of a complication that arises is that, if the standard formation works Monday to Saturday, the demand for first-class seats may be less on Saturday than on the other days of the week. On working days a large part of the demand is accounted for by business travellers. To maintain the formation, without wasting accommodation, it may be possible to sell first-class travel at cheaper rates on Saturdays and thereby encourage more people to travel in first-class seats. Advocacy of standard formation might appear to conflict with the counsel given elsewhere in this book to reduce the weight of trains by keeping the number of vehicles per train to a minimum. Standard formations necessitate a carriage working being formed with sufficient vehicles to cope with the passengers offering on each train within the diagram. This must result in empty seats being hauled on the journeys where demand is light.

In spite of the apparent confliction—railway operating is not the most exact of sciences—in these recommended courses of action, they are both worth bearing in mind and applying according to the circumstances. Certainly the standard formation should not convey seats in excess of the maximum demand on the whole diagram. From what has been said, it should be realized that standard formations have such substantial advantages that often they must take priority over other considerations.

Because it was mentioned earlier that a large part of the locomotive-

hauled main-line vehicles have no regular daily working, and only work at holiday times, the reader may be puzzled at the insistence on the daily carriage workings providing for the intense utilization of stock. Why not, he might say, share the work out among the whole fleet? There are a number of reasons:

(1) If the carriage workings allow long turn-rounds at terminals, the platforms have to be freed. This involves unnecessary movements and unnecessary trains between stations and carriage sidings.

(2) A set of coaches which travels 300 miles a day needs complete exterior washing once a day in the same way as a set which does 400 miles. Carriage cleaning costs do not rise proportionately with increased mileage. But this is more than a question of cost. Railway carriage cleaning is not the most attractive of jobs. When there is a brisk demand for labour it may be difficult to maintain the establishment. In consequence, one must make the best use of the cleaning staff. It is better that they should clean a small number of vehicles thoroughly rather than clean a larger number of vehicles inadequately. The latter course is a certain way of getting dissatisfied customers. But by using the smaller number intensively it is possible to cover the same passenger-train mileage as with the larger number used more casually.

(3) Except for a few months in the summer it is necessary to heat passenger coaches. In order that the passenger accommodation is at a proper temperature when the passengers join, preheating is required before the journey commences. The cost of doing this varies according to the type of heating and the facilities available for doing it, but it is often substantial. Preheating is reduced to a minimum by forming trains from incoming services and by covering the maximum number of trains with the minimum number of sets of coaches. Not only is this the most economical method, it is the best way of keeping passengers warm.

(4) At any time the fleet of coaches consists of some new vehicles recently added to the fleet, some not so new, and some old ones which will shortly be scheduled for scrapping. The most modern vehicles are normally the best from the passengers' point of view and are easier to clean and to keep warm. Therefore, if the operator must hold main-line vehicles in sidings out of use for months of the year in order to meet occasional peak demands, those put away should be the older vehicles. The modern ones should be kept in maximum use, thus giving the greatest comfort to as many passengers as possible. By using the smallest number of vehicles for the regular workings, only modern vehicles need be in daily use on the main-line services.

(5) The final reason for insisting on the most efficient daily carriage workings is that it may be decided to reduce the size of the fleet because

the peaks have been reduced by the methods mentioned in Chapter 13 or by other causes. Alternatively, it may be decided that it is not economical to retain stock to meet peaks to the same degree as at present. In either of these circumstances, estimates of the optimum number of vehicles to be retained should be based on the most efficient carriage workings.

MAKING THE BEST USE OF MODERN VEHICLES

As stated in item (4) above, it is necessary to ensure that the best vehicles are used and that only the older ones are stored away until peak times. The regions adopt different methods with this aim in mind. The most effective method is also the simplest one. It works like this:

(*a*) All vehicles built since a certain date have a letter "*A*" printed on the ends.

(*b*) Most regular main-line expresses, plus other services which justify their inclusion, are scheduled to convey only "*A*" stock.

(*c*) There are enough "*A*" vehicles to supply all these trains plus spares at strategic locations to substitute for any vehicles withdrawn from service for repair or other purposes.

(*d*) As new vehicles are supplied, increasing the "*A*" stock, either more trains are scheduled to carry it, or some earlier "*A*" vehicles are delettered.

Other systems designed to provide the newest and best vehicles for the more important services sometimes involve keeping records of individual vehicles and their condition. They are most likely to fail when a vehicle has to be taken out in an emergency. The shunter has no method of ascertaining the interior condition of possible replacement vehicles without climbing up and examining them. He may, therefore, use a vehicle which is not up to standard. The Coaching-Stock Controller from his records or from examination of the vehicle, may decide that the vehicle actually used as a substitute was by no means the best. If, on his direction, the unsatisfactory vehicle is replaced by a better one the matter is put right, but this is not so satisfactory as correct substitution in the first place. In the "*A*" system previously mentioned it is quite clear to everyone concerned, even from ground level, which vehicle has a modern interior.

DISTRIBUTION

An efficient distribution system is essential to meet demands promptly and to keep down costs. In contrast to the bulk of the freight rolling-stock fleet which is in common ownership between the regions, coaches and multiple-units are allocated to regions and are suitably identified.

There is, of course, inter-working of coaching rolling-stock between regions and there are occasions of peak demands special to a single area, which may call for the loaning of vehicles from other regions.

Multiple-unit allocations are based on the number of scheduled workings (diagrams) to be covered, plus an allowance for replacing sets withdrawn for maintenance purposes. Many locomotive-hauled vehicles have scheduled workings also, and if they are engaged fairly intensively each weekday, the question of distribution does not arise. They might, however, be used to work trains on Sundays. Therefore, the daily report submitted by stock-holding stations is mainly concerned with vehicles on hand not on scheduled workings, vehicles specified for working relief and other trains, and vehicles required to make up extra trains on subsequent days.

The station reports, which indicate details of vehicles surplus or required additionally, are communicated to the District Office coaching-stock controller who equates surpluses and shortages between the various stations. This is a similar process to that employed with wagons. The main difference is that the coaching vehicles are controlled as individual vehicles instead of as a type. The vehicle numbers are set out in the daily report. From this number the controller can establish more details of the vehicle, which is necessary if each one is to be used to the best advantage. For example, there are several designs of main-line corridor second-class-compartment vehicles. Designs may vary in weight, in the number of seats, and in the number of doors. Another important consideration is the date of manufacture. Any of these features may have to be taken into account in establishing the suitability of a vehicle for a particular purpose.

Apart from their individual numbers, coaches are described by code letters which indicate the main group to which they belong. These include:

B Brake
C Composite
F First-class
K Corridor vehicle with compartments
O Open (i.e., no compartments)
R Restaurant car
S Second-class.

They may be grouped together; thus we know that a BSK is a corridor vehicle with compartments of second-class seats, and also has a brake compartment; an FO is a first-class open coach, and so on.

Establishing the correct size of the main-line coaching-stock fleet is a difficult task and all the relevant factors of cost and earning capacity

must be taken into account. The fleet is likely to be larger than the minimum number of vehicles required to work the daily scheduled services, in order that the railway may get a share of the irregular traffic to seaside resorts, sports meetings and so on. It is certain to be smaller than the number of vehicles required fully to meet all demands on the busiest days of the year, as this would lead to excessive unemployment of vehicles at the off-peak periods. This leaves the traffic department with two problems: (1) how to get the best use out of the vehicles surplus to normal daily requirements; (2) which traffics to accept and which to reject on the peak demand days.

The first of these problems calls for a lively commercial policy of anticipating the travelling tastes of the public, meeting these tastes with a programme of excursion trains and then selling the service to potential travellers. However, it must be realized that there are many other considerations apart from making the best use of the passenger coaches. Line occupation, availability of locomotives and crews all affect the issue and may prohibit some attempts to improve passenger-rolling-stock utilization.

So far as peaks are concerned, it has already been emphasized that stock must be kept on the move and moved quickly. It is equally important to ensure that the vehicles are used on those services where they will bring in the greatest revenue. This means that the vehicles should be used where they can be most fully loaded. Fares should be the highest at which passengers will travel by rail. Therefore, on say the peak Saturdays in the summer, full fares should be extracted. Cheap travel facilities should be reserved to improve vehicle utilization and loading at off-peaks.

LOAD FACTOR

The overall load factor of passenger trains on British Railways is poor. On average more empty seats than full ones are conveyed. This may be caused by:

(1) Heavier flows of passengers in one direction at particular times may necessitate empty seats being conveyed in the opposite direction to maintain a balance of coaching stock.

(2) The use of standard formations.

(3) Seats being required for only a part of a train's journey.

(4) Variations in traffic levels.

However, it is necessary to examine regularly the economics of lightly loaded trains with a view to their withdrawal, and at the same time to keep the loads of all trains to a minimum consistent with the passengers' comfort.

Attempts should be made to fill the seats by offering travel at reduced fares, but these should be used only when they increase gross revenue. Cheap mid-week period fares, off-peak day return fares, and cheap evening fares are a few examples of existing facilities which attempt not only to fill the empty seats in the off-peak periods but also to lure some traffic away from the peak.

CARRIAGE CLEANING AND SERVICING

Where steam locomotives are still employed they are a source of smuts and grime. This makes the task of keeping passenger accommodation clean a particularly onerous one. Wherever possible, coaches should be segregated from steam locomotives. It is desirable that windows should be kept closed when trains are standing in the sidings to prevent unnecessary dirt from entering the carriages. It is equally desirable that they should be closed when in service, but as this is largely under the passengers' control it is difficult to achieve unless air-conditioning equipment is installed.

The cleaning and servicing to be performed, on time-table trains is scheduled in carriage-cleaning rosters, which are part of the plan of operation. These set out the services to be undertaken at each depot or station. Carriage-cleaning depots, which should be close to the terminal served to reduce empty running, are required to see that all vehicles are properly cleaned and serviced (lavatory tanks filled, soap and towels replenished and so on) before going into traffic. Although carriage cleaning is normally done by railway staff, it may be worth while to ascertain if some of it could be done more efficiently or more economically by outside contractors. It has already been shown that the working for one set of carriages may cover a number of trains in a day, and that the vehicles may not enter any cleaning sidings during that time. It is also necessary to arrange for intermediate cleaning and servicing as the opportunity occurs at terminals during the day. In view of what has been stated already about the desirability of making intensive use of stock and reducing movements between the station and the sidings, this is extremely important. When the operating situation does not permit movement to be maintained, efforts should be made to use the standing time for cleaning, servicing or maintenance.

Cleaning operations are normally grouped under four headings:

(*a*) *Daily cleaning*, which includes exterior washing, interior floor washing and general cleaning.

(*b*) *Intermediate cleaning* at terminal stations, which is normally confined to window washing, door-handle cleaning and general interior cleaning, particular attention being paid to lavatory compartments.

(*c*) *Exterior periodical cleaning*. This is a special cleaning of exterior paintwork using special solutions.

(*d*) *Interior periodical cleaning*, which includes washing ceilings and interior paintwork and the vacuum-cleaning of upholstery.

In addition special chemical cleaning of upholstery is carried out periodically.

Once the carriage-cleaning rosters have been worked out it can be established precisely what work has to be done at a particular depot for regular services. Proper time allowances are allocated for each task according to the methods employed and the equipment available. From the amount of work to be done and the time allowances for each job, one can calculate precisely how many cleaners are required for regular work. Unfortunately, additional work falls on most depots for the cleaning of extra trains (relief trains, excursions and others) and this cannot be calculated with such accuracy in advance. Scheduled services sometimes convey extra vehicles and this also increases cleaning work. Having made rough estimates of likely obligations, special problems are presented by the peaks—particularly the seasonal peaks. The number of cleaners required in the winter months may be inadequate during the busy summer period. In addition, cleaners wish to be released for their holidays in the summer, so the operator is in danger of having the most cleaning to do at a time when he has the least staff to to it.

Some increase in staff is desirable at the seasonal peak times but it may be difficult, or impossible, to recruit the right type of staff for this work for a short period only. To employ sufficient staff throughout the year in order to be able to cope with peaks is likely to prove uneconomic. It may be justifiable, however, to maintain an establishment slightly larger than that required to do the cleaning at the quietest time of the year. This surplus may then be employed to do special cleaning; e.g., chemical cleaning of upholstery, or even to catch up on periodical cleaning which has perforce been slightly neglected at peak times. Only limited achievements are possible in this direction as cleaning cannot be stored. If much time elapses between its performance and the use of the vehicle, the standards of cleanliness are likely to prove unsatisfactory.

To obtain efficiency in carriage cleaning a number of factors must obtain, apart from an adequate number of staff. Once more the question of design influences the work. A reduction in ledges, protuberances, and other dust traps makes cleaning easier. Likewise, accessibility of all parts of the vehicle which the cleaners require to reach, speeds the work and leads to greater cleanliness. One other

important feature is the selection of easily cleaned materials for walls, seats etc. The increase in the use of glass in recent designs tends to increase the time taken to clean carriages.

Mechanization of cleaning processes is desirable to reduce the size of the labour force required, to make the work more pleasant for the people employed and to improve standards; the exteriors of carriages lend themselves to this quite readily. Various types of carriage-washing plants are employed. A common procedure is for detergents to be sprayed over the carriage body and windows, after which the vehicle passes through revolving flails or Nylon brushes, and finally high pressure water-jets wash away both detergent and dirt (see Plate 26). This process can be performed in minutes, whereas the washing of exteriors manually takes one or two man-hours per vehicle. The cleaning of interiors calls for human supervision. When electrical floor scrubbers and vacuum cleaners are used, they require manipulation.

It is perhaps, more difficult to become enthusiastic about efficient carriage cleaning than for, say, efficient train working or marshalling-yard operation. Because of its mundane nature there is a temptation for the operator to regard it as a matter of less importance. It is the wrong approach for those concerned to pay an interest in it only when a complaint is received. Most passengers do not trouble to complain, but the absence of complaints does not indicate satisfaction. Firstly, it must be recognized that cleanliness makes a great difference to the passengers' comfort. Secondly, it must be appreciated that the people engaged on this rather unpleasant work are worthy of approval for their good work. If this is done, they will respond better to a criticism of neglect when a complaint arises. They must be encouraged to work diligently. Bonuses and piece-work rates are often used. Cleaning staff must be equipped with good cleaning materials and mechanical aids. They should be encouraged to take pride in their work, and this may be helped by:

(*a*) Keeping the newest and best vehicles in regular sets.

(*b*) Forming diagrams which bring the same vehicles back to a particular depot each night for cleaning. This conflicts sometimes with the need for diagrams to provide for maximum utilization, and the two opposing considerations can be settled only by discretion, according to circumstances. If a vehicle is based at a particular depot, the cleaning staff employed there take a greater interest in its condition than in a vehicle which is cleaned at different stations on different occasions. With the latter there is an inclination to do the minimum work and leave the more arduous tasks for someone else. When the cleaning of a vehicle is the responsibility of one depot, or better still one gang or one

cleaner, the highest standards are achieved and responsibility for any shortcomings can be readily apportioned.

(*c*) Adequate and thorough supervision. This should not be confined to the cleaning foreman, important as his role is. His surveillance should be supplemented by periodic inspections by the depot master and by district or other officers.

Two other effects of intensive utilization on cleaning are the necessity to do more cleaning during the night time and to provide travelling cleaners in some cases. If stock is kept on the move during the day the only opportunity to clean it may be during the night. This inflates wages costs, because of higher night rates, and demands good lighting in carriage-cleaning sidings and depots. It may not be permissible to use the normal carriage lights for cleaning as this may run down the batteries. Therefore, illumination may be required for both interior and exterior cleaning. The provision of travelling cleaners may be necessary either to clean carriages during long journeys or on short trips where a series of quick turn-rounds does not permit intermediate cleaning at terminals. The work that may be done by travelling cleaners is normally restricted to empty compartments, corridors and lavatories.

The conduct of passengers affects the cleanliness and tidiness of vehicles. Their co-operation must be sought and the following measures may help:

(1) Start clean. People tend to respond to their environment. If they are presented with a clean vehicle they are more likely to keep it clean. They may not behave equally well in a dirty one.

(2) Provision of adequate ash-trays, litter bins and other aids to tidiness.

(3) Persuasion by posters or loudspeaker requests.

SUMMARY

1. *Coaching-stock costs depend on the extent to which vehicles are used.*
2. *Minimum costs will obtain when a time-table provides for intensive utilization.*
3. *Standard formations and standard designs improve utilization prospects.*
4. *Speed turn-rounds—Most easily achieved with multiple-units.*
5. *There is no payment for empty seats hauled.*
6. *Peaks inflate the size of the fleet.*
7. *Watch the tare weight per passenger seat.*
8. *Keep best vehicles in regular use.*
9. *Clean carriages are important to passengers—Therefore carriage cleaning is important to the operator.*

CHAPTER 5

Motive Power

THE aim with motive power is to move the maximum amount of traffic as quickly as possible, at the minimum cost. Motive-power costs per mile depend on:

(1) Initial cost and life of the locomotive, which will determine the annual charges for interest and depreciation.

(2) Maintenance costs for maintenance done on a time basis.

(3) Running costs, comprising fuel, lubricants, etc., manning costs, and costs of maintenance performed on a mileage basis.

(4) How much work the locomotive performs in a given period.

Two identical locomotives should have equal costs but if one of them works twice as many ton-miles or passenger-miles as the other, the costs per unit of work performed will only be half in respect of items (1) and (2). Of course costs under (3) will tend to rise roughly in proportion to any increased mileage incurred. Cost, maintenance requirements, running costs and availability for work depend on the type and design of motive power employed.

ELECTRIC TRACTION

Initial costs are much higher with electric traction than with the other forms of motive power. A large part of this cost is absorbed in the erection of structures to convey the electric current to the motive-power unit. The conversion of a line to electric working frequently involves substantial engineering works on track, structures, signalling and telecommunications. This takes a long time and disturbances to the existing services during conversion are likely. Because of the high costs involved, electrification can only be justified where there is a sufficient density of traffic. Under electrification, however, the movement costs are relatively cheap, and in consequence the greater the density of traffic the more favourable is the comparison in respect of electricity. In addition, it meets the main operating requirements of reliability, good acceleration, and speed. Whereas the power of steam and diesel locomotives is limited by restrictions on their dimensions, the power of the electric locomotive can be varied by drawing large amounts of electricity from the supply network for short periods. This

reserve of power is most important when trains are starting, and on gradients. An electric locomotive holds the world rail-speed record.

Electric locomotives require to be out of traffic for maintenance less than either diesel or steam locomotives. They can be available for work continuously for days on end without requiring maintenance. In addition, they have an advantage over steam and diesel locomotives, in not requiring to go into the depot to be refuelled. This freedom from the need to return to the motive-power depot for maintenance or fuel is most important to the operator, because it enables him to use the locomotive for traffic purposes without interruption and it eliminates light running between the terminals and the motive-power depots, which wastes the time of locomotives and crews and uses up line capacity.

Railway electrification may use direct current (d.c.) or alternating current (a.c.). It may be supplied by conductor rails or by an overhead contact system. The present standard system for new electrification is 25,000 volts a.c. This replaced the previous standard which was the much lower voltage of 1,500 volts d.c. (Plates 16, 17 and 18). A considerable part of the electric lines including those on the Southern Region work on 630/660 volts d.c. (Plate 19). Much of the electrification on the Southern Region was done in the first quarter of the century, and it will be seen that there has been a progressive increase in voltage, which has been facilitated by technical developments. As higher voltages have been used, so fewer sub-stations have been required. This has reduced the cost of power-supply equipment and the present standard voltage permits the use of electricity from the national grid system without the use of rectifiers. An overhead contact system has replaced conductor rails as these are not suitable for high voltages.

Although the use of 25,000 volts permits lighter conductor wire and supports to be employed than with 1,500 volts thereby reducing construction costs, it has the disadvantage of requiring greater clearances between the contact wires and earthed structures and between the wire and the vehicle. During electrification work this often necessitates (1) alterations to bridges or tunnels, or (2) the stepping down of the supply voltage in these locations, or (3) a combination of both. A further advantage of the use of very high voltages is that there is less likelihood of the locomotive wheels slipping on the rails. This permits lighter locomotives to be built for the same hauling capacity. In spite of these considerable advantages, it is not necessarily economic to convert existing d.c. sections of line to the standard voltage. Indeed, where electrification is planned on contiguous sections to existing d.c. lines it may well be best to extend the d.c. system, at the voltage employed on

the neighbouring lines, to permit through working without voltage adjustments. Electric traction is not dependent on imported fuel, but its economical application is conditional upon a cheap supply of electricity. An advantage is that it is the only present form of inland transport which can exploit electricity generated from nuclear energy.

DIESEL TRACTION

On those lines on which there is insufficient traffic to justify electrification, some form of diesel traction is normally the most efficient alternative. Because of the substantial engineering work necessary to prepare for electrification there may be a lapse of some years between the decision to electrify and the introduction of an electric service. In this case it might be desirable to replace steam traction by diesel traction in the meantime. In other circumstances, diesel traction may be the most suitable form of locomotion on a permanent basis. This applies particularly on lines with only modest traffic.

Diesel traction is cheaper to introduce than electric traction as it does not call for costly constructional work on the line. However, diesel locomotives are more expensive than either electric or steam locomotives of equal power. One costs several times more initially than a similar steam locomotive. To offset this it has a number of operating advantages as compared with steam traction including:

(1) It should be available for traffic more continuously.

(2) Cheaper running costs—providing it is properly used. Although the initial costs are higher the depreciation can be spread over a greater mileage. Therefore, the depreciation costs per train-mile may be less. In addition fuel costs are lower with diesel traction and manning costs may be less. The diesel locomotive does not require as much attention as a steam locomotive and the maintenance and servicing costs per mile are also likely to be smaller, with the same proviso as above, i.e. that it is used intensively.

(3) Acceleration is normally faster than that of a steam locomotive, but often less than that of an electric locomotive. The actual acceleration depends on the power/weight ratio and other factors. It is important that the operator should realize that acceleration has to be paid for, and he should not demand extra power without weighing the cost of providing it against the operating advantages that will accrue from having the greater power.

(4) The diesel locomotive needs to return to the motive-power depot less frequently than a steam locomotive, and therefore there is less need to interrupt train movements for a change of motive power. Fewer movements to and from the depot have similar advantages to those listed

under electric traction, but diesel locomotives require fuel at fairly frequent intervals (many carry fuel for about 400 miles), and maintenance attention more often than electric traction units. The diesel locomotive may be available for traffic for about 22 hours out of each 24, except on the day it is required for weekly maintenance.

(5) Both diesel and electric locomotives can normally be driven from either end, which permits faster turn-round than is possible with those steam locomotives that require turning.

There are three main groups of diesel locomotives. The divisions depend on the type of transmission system used:

(*a*) *Diesel* (*Mechanical*). A mechanical transmission, as used on most road vehicles, is simplest and cheapest but is not suitable for machines with high horsepower. It is often employed on multiple units and shunting locomotives.

(*b*) *Diesel* (*Hydraulic*) uses fluids in the transmission system. This type of locomotive is most common on the Western Region.

(*c*) *Diesel* (*Electric*). The diesel engine drives a generator, which supplies current for the traction motors. This is a form of electric traction without the use of the current-distribution apparatus necessitated by full electrification. Each locomotive is in effect a mobile power station. Naturally, it has advantages over full electrification such as greater flexibility in use, and it may be introduced without the waiting period which is an unavoidable preliminary to full electric working. But it has disadvantages too. As one would expect it is a complex and expensive machine, and it does not have the reserves of power to draw upon which the locomotive supplied with electricity from an external source has. There are a small number of diesel-electric locomotives which can take the power from the overhead lines when running on electrified lines, and which generate their own power on non-electrified lines.

There are a number of different types of diesel multiple-units. As there is no standard coupling device, care has to be taken in coupling sets together. A coupling code is painted on each end of a diesel unit. Cars with like symbols may be coupled, but those with dissimilar symbols may not. An important disadvantage of the diesel-powered engine is its dependence on imported fuel.

STEAM TRACTION

Although new steam locomotives are no longer built, it is likely to be some time before the existing machines are all withdrawn. Their initial purchase prices were certainly less than either their diesel or electric counterparts; they also have a long life and consequently annual depreciation charges are small. What then are the shortcomings

which have led to the progressive abandonment of steam traction?

(1) *Poor availability.* Frequent visits to the motive-power depot are necessary for coal and water supplies, cleaning of fire-box, smoke-box and ash-pans. In addition water supplies have to be made available outside the motive-power depot. The most satisfactory supply is the trough which permits water to be taken while the train is moving at speed; this is achieved by means of a scoop on the locomotive. Where the expense of this cannot be justified, fixed supply points should be at locations where trains stop for traffic purposes, thus reducing the total number of stops required. The locomotive has to be taken out of service at frequent intervals for boiler washing, boiler inspection and for tube cleaning as well as for repairs. Some of the work can be done only after the boiler has cooled down and the locomotive is thus delayed for several hours. After the fire has been extinguished for any reason, the reheating of the boiler takes several hours before the locomotive can become operational once more.

(2) *Demands on labour.* The various cleaning activities mentioned in (1) are dirty, heavy and generally unpleasant jobs. It has become increasingly difficult to find suitable men to do the work. Because of the enormous appetite for fuel of the steam engine the job of fireman is also an arduous one for which it is sometimes difficult to find recruits.

(3) *Poor utilization.* The interruptions to availability set out in (1) are not conducive to good utilization. Time is absorbed in going to and from the motive-power depot, and servicing needs interfere with the main requirement of good utilization, i.e. keeping moving.

(4) *Poor thermodynamic efficiency.* Engineers assert that the steam engine is one of the most inefficient methods of using coal that was ever devised. Be that as it may, one does not need to be an engineer to appreciate the waste of fuel involved when movement is not occurring. Fuel is consumed for hours before the engine leaves the depot, throughout the time it is in traffic whether it is moving or not, and again for hours after returning to the depot.

(5) *Unreliability in performance.* The steam locomotive has a limited ability to sustain maximum power for lengthy periods. How well this is achieved depends to a large degree on the type of fuel used, the skill of the engine crew and the condition of the locomotive. This is not conducive to reliable performance.

(6) *Fuel-supply difficulties.* The price of coal has risen disproportionately to most other commodities since about 1945. The best quality coal, which is the most satisfactory for British locomotives has been difficult to obtain, and the use of inferior qualities has accentuated the difficulties set out under previous headings.

(7) *Preparation and disposal.* As previously mentioned, the frequent trips to the locomotive depot for servicing absorb the time of engine crews and increase line occupation. In addition, many steam-engine crews spend about a quarter of their shift in preparing the locomotive before leaving the depot and in disposing of it on return. Preparation includes oiling, examination of specified parts of the locomotive, and building up steam pressure. Disposal usually includes taking on coal and water, cleaning of fire-box, smoke-box, and ash-pan, and moving the locomotive into position for examination by mechanical staff for defects. To increase the availability of an engine crew for train working, preparation and/or disposal may be performed by depot staff or other engine crews who cannot be found a full shift of train working.

(8) *Air pollution.* The emission of black smoke can result in prosecutions under the Clean Air Act, but there are numerous difficulties arising from air pollution apart from legal ones. Mention was made of one in connection with carriage cleaning in Chapter 4. The deposit of grime on railway property, which inconveniences passengers and increases cleaning and painting costs, is another. Dirt deposits on customers' freight may lead to claims, extra expense in protecting the freight or sometimes the loss of the traffic. Even worse is the occasional ejection of red-hot cinders. These sometimes result in claims for compensation for line-side fires and may necessitate expensive precautions being taken for the protection of freight.

RELATIVE VALUES OF THE MAIN TYPES OF MOTIVE POWER

Having taken a brief look at each of the three main groups, the position may be summed up briefly that the initial costs are highest for electric traction, with diesel traction second and steam cheapest. Diesel traction as a whole is least costly in terms of fuel but, in comparison with electric traction, this is more than offset by considerably higher costs for provision and maintenance. The running costs for steam traction are the highest of all.

From most operating points of view the advantages lie in the same order; electric best; diesel second and steam the least satisfactory. Better availability and utilization permit one electric or diesel locomotive to perform three or four times as much work as a steam locomotive, and therefore as steam locomotives are replaced, the total size of the fleet should be progressively and substantially reduced. Faster acceleration, higher speeds and quicker turn-rounds of electric and diesel motive power enable the train crews to perform more work in a shift, and economies should follow from this. In addition, the operation of electric and diesel locomotives is basically a one-man job, whereas

a steam engine needs a two-man crew. This advantage has not been fully exploited because of restrictive agreements with the trade unions, but some single manning does occur. One hopes for a relaxing of the restrictions on single manning in the future to permit a better use to be made of labour and to reduce operating costs. Further reference is made to this matter in Chapter 9.

One important exception to the operating advantages of electric traction is the difficulty caused by the power supply being confined to particular routes. This causes particular hardships if the electrified line becomes obstructed. In this case, the only routes over which trains may be diverted, using their own motive power, are those also electrified at the same voltage as the obstructed route.

Both electric and diesel motive-power units are available for traffic purposes for longer periods than steam locomotives, and the operator must ensure that advantage is taken of this. The greater the use made of them, the greater is the economic gain to him. As long as steam locomotives are used, it is also important that they should be fully employed as far as the circumstances, previously described, permit.

It is now necessary to consider how the operator seeks to make full use of each type of locomotion and what factors militate against full utilization.

MAKING THE BEST USE OF MOTIVE POWER

Allocation. Motive-power units are allocated to particular depots. The allocation is based on:

(*a*) The number of booked regular workings (diagrams) scheduled to be performed by locomotives of that depot.

(*b*) An allowance for working extra trains, which may require hauling by locomotives from the depot.

(*c*) A cover for units which are likely to be unavailable for traffic purposes on account of repairs or maintenance.

Different types of trains require different types of locomotives, so the allocation will not be so many locomotives, but different numbers of different types. The allocation may need to be varied from time to time in accordance with variations in traffic demands.

In making the allocation, the desirability of keeping light running to a minimum must be borne in mind. It is also necessary to take into account the repair capacity of each depot and the number of staff, both footplate and maintenance, employed there. Maintenance costs will be reduced if particular depots are allocated the fewest different types. A direct saving in the number of locomotives provided under (*c*) will result, and also in the stocks of spare parts required.

Availability. As far as item (*c*) is concerned, the number required will depend on the proportion of the allocation which the motive-power department is able to make available for traffic. From the operating point of view it would be desirable if repairs and maintenance could always be performed on a locomotive when it was not required for traffic; in other words, that work on locomotives should always be done at off-peak times. However, one must consider the work inside the motive-power depot and inside the main works where locomotives go for major overhauls. Some continuity in the supply of work is essential, and major repairs may put a locomotive out of commission for several weeks. Once again we are confronted with a conflict between the needs of different railway departments. The question of improving the availability of locomotives is a subject for a book on motive-power practice rather than one on operating practice. It will suffice to say here that maximum availability should be borne in mind and that in ascending order the best availability may be expected from steam, diesel and electric locomotives, for reasons already outlined.

Utilization. Efficient diagramming will reduce the numbers of each type of locomotive required under headings (*a*) and (*b*) of *Allocation.* This will be discussed in Chapter 9. So far as extra and special trains arranged at short notice are concerned, the onus of making efficient use of locomotives rests on the Control Office; see Chapter 10. As with freight and passenger rolling stock the most important single cause of bad utilization is the peak demands, both daily and seasonal. This is aggravated if the motive power has been specially designed for a particular type of work. The most obvious example is the multiple-unit. If some multiple-unit sets are required only in the daily peaks obviously they will be unemployed for the rest of the day. To keep running costs down, their power has been related to the normal weight they are required to move, and they do not possess a reserve of power sufficient to haul a freight train. Prolonged time out of service is not confined to those multiple-units employed only at peaks because, by the nature of the work performed, virtually the whole of the fleet is out of traffic during the night hours. Passenger travel in the evenings has fallen off in recent years, which aggravates the situation. The resultant poor utilization suggests, that, if economic use of motive-power were the only consideration, which it often is not, the correct way to plan a locomotive fleet would be:

(1) To establish the needs of freight traffic and work out the most efficient diagrams, using mixed-traffic engines on all diagrams which are not fully productive.

(2) To plan for this unproductive time of locomotives to be absorbed on passenger services as far as one could.

(3) To employ only sufficient multiple units to cover the residue of the passenger service.

The other advantages of multiple-unit working as described elsewhere, may be of such importance that full use of the motive power may have to take second place. But if it is remembered that motive power is usually the largest single item in train-movement costs and as motive-power costs vary according to utilization, the methods just proposed have much to commend them.

The same kind of disability applies to any locomotive with a specialized design. The locomotive built specially to haul only freight or only passenger trains must perforce stand idle at times when the particular traffic it was designed to move is not passing. This is the same phenomenon that we observed with freight and coaching rolling stock—specialization militates against full utilization. Consequently, the mixed-traffic type of locomotive has much to commend it. There is inevitably a lull in passenger travel during the night hours and the demands of freight transits necessitate an intensification of freight movement during the night. Therefore the mixed-traffic locomotive has a better chance of being fully employed.

Selecting Locomotives of Correct Power

Another way in which the design and utilization potential of motive-power units are interwoven is in their hauling capacity. The unit may be required to work small, medium or large trains, or a combination of these. It is wasteful if a unit is constantly engaged in hauling trains which are smaller than it is capable of hauling. It probably costs more than a smaller unit which could do the job equally well, and is more expensive to run. On the other hand, many different types of locomotive graduated according to their power, are difficult to use fully. A careful balance must be kept between these considerations to ensure that the most economic use is made of motive-power.

There is an important distinction to be made in this connection between steam on the one hand and diesel and electric traction on the other. With steam, the use of two locomotives to pull one train (double heading) is blatantly expensive because two engine crews are employed instead of one. With electric and diesel locomotives the controls for the two locomotives can be operated by one driver from the leading cab and crew costs do not vary whether a train is single-headed or double-headed. This seems to indicate that there are not as many good reasons for different types of these locomotives as there

were with steam. Using small or medium locomotives in tandem on large trains and using them singly on small ones, reduces wasted power in working small trains and enables units to be kept working with more continuity. It is not desirable to over-simplify this issue, which is difficult to resolve if the aim of working traffic at the cheapest motive-power cost is to be achieved. Complicating factors are that:

(1) One powerful unit would not normally cost as much as two units each with half that power; e.g. a 2,000 h.p. unit is usually cheaper than two 1,000 h.p. units.

(2) There is likely to be less locomotive weight in one large unit than in two small ones of equal power. It is important to remember in locomotive design that the greater the weight of the unit itself the less will be the power available for hauling.

(3) One larger unit is likely to be shorter than two small units.

There still seems to be a case, therefore, for the use of some powerful units for which a fair continuity of work of hauling heavy trains is available. However, in other cases the most efficient method would appear to be to keep small units continuously employed by individual or tandem working, according to the size of the train. One would hope that this will lead to a reduction in the number of different types, and in the disadvantages which inevitably accompany the employment of many different pieces of equipment. The ability to keep locomotives employed is also affected by a further design factor, discussed below.

Route Availability. The axle weight of locomotives tends to be higher than those of freight or passenger rolling stock. The weight of the larger and more powerful locomotives is greater than certain bridges and other parts of the track can bear. Track curvature, limited clearances or other circumstances also require certain locomotives to be prohibited from certain sections of track. The method of applying these restrictions is as follows. All routes are classified. All locomotives are classified according to their " route availability." All staff concerned are advised which class of locomotive may pass over which class of route. A locomotive must not pass over routes outside these permissions without special authority. Restrictions on route availability may reduce utilization. For example, if an incoming train arrives at 12.30 p.m. from route "*A*," there may not be an outgoing train on route "*A*" until 2.30 p.m. However, if a locomotive which has worked this train was also permitted to run over route "*B*," it could possibly work the 1.0 p.m. departure.

Running Light. The line occupation and other costs of a locomotive running without a train, previously mentioned, suggest that the light-running mileage should be kept low. Good planning of train services,

scientific diagramming and intelligent controlling will help to do this. However, some light running is sometimes necessary in order to do the work with the minimum number of locomotives and men. There is also some light running which is inevitable; for example, some journeys between the motive power depot and the station or yard.

NUMBER AND LOCATION OF MOTIVE-POWER DEPOTS

The location of motive-power depots affects operating costs. To reduce light mileage to a minimum, the depot should be situated close to the main terminal which it serves. Land may be too expensive in the environs of the terminal, or not available at all, and in this case the operator must carefully plan the movement of locomotives to and from the depot, which is situated some miles away, to avoid overtaxing the line capacity. It may be necessary to despatch two or three locomotives coupled together to reduce line occupation, but this has disadvantages both in the motive-power depot and at the terminal. In particular, the extra movements which this causes at the terminal may retard train movements. Coupled running from the motive-power depot to the traffic terminal involves some locomotives leaving unnecessarily early and therefore has a bad effect on utilization.

A separate motive-power depot serving each main traffic terminal reduces light-engine mileage. If the motive-power unit has to travel from a distant depot, in addition to the cost of light mileage, special operating costs for signalling and level crossing operation may arise before the train service commences to operate, and again after it has ceased. However, there are drawbacks in having many small motive-power depots instead of fewer larger depots, and this may include:

(1) More overhead expenses.

(2) More staff may be required; it may be more difficult to keep staff continuously employed. Large depots can divide labour functions to increase productivity.

(3) More locomotives may be needed. It is necessary to have units to cover maintenance and repair requirements for each type of locomotive. This can be done most economically at a large depot.

(4) More spares to be kept in stock.

(5) Mechanical aids for servicing locomotives may not be economically justified at a small depot. They might be at a larger one. This helps to keep staff costs at larger depots lower than at smaller ones.

It is sometimes possible to leave electric or diesel motive-power units at traffic terminals overnight to avoid light running to and from the depot. In this case the traffic terminal should be a signing-on and signing-off point for the drivers concerned.

The number and location of motive-power depots will also affect the speed of replacement of locomotives which become defective in traffic. If depots are widely spaced the replacement locomotive may have to travel a considerable distance before it can take over. On the other hand, the chances of a large depot having an appropriate locomotive and crew available are better than at a small depot.

BREAKDOWN TRAIN

As the motive-power depot is normally the location of the accommodation for the breakdown train, the location of the depots affects the time taken to get to the scene of the breakdown. Special measures need to be taken to assemble the crew of the breakdown train quickly at any time of the day or night, and once it leaves the depot it has to be accorded a high priority to enable it to reach the scene of the mishap quickly.

CO-OPERATION BETWEEN MOTIVE-POWER DEPARTMENTS AND OPERATING DEPARTMENTS

The successful operation of a train service having the lowest motive-power costs depends to a large extent upon co-operation between the motive-power and operating departments. The term *interdependence* has been mentioned several times already. Nowhere is it more evident than in this connection. Unless the motive-power department can provide the right type of locomotive in good condition, at the place and time required, the operator cannot carry out his work efficiently. Conversely, if the operating department do not return the correct locomotives to the depot promptly, the motive-power department cannot do its work satisfactorily. Subject to traffic requirements, the scheduled departures of locomotives from the motive-power depot should be spread evenly throughout the 24 hours to facilitate the work within the depot.

Reliability is vital. To reduce locomotive failures in traffic, a proper programme of preventative maintenance is required. Drivers submit a defect list after each trip in order that minor repairs may be done before small defects lead to delays. This is supplemented by periodical examinations by mechanical staff who give attention as necessary. The operator must return the motive-power unit to the appointed shed at the proper time, if the work of preventative maintenance is to be performed strictly according to the programme. This, and thorough maintenance by competent engineers, is the best way of obtaining reliable motive-power performance.

With the use of the breakdown train it is necessary for close liaison to be maintained. The operating department can help by:

(1) Not calling out the breakdown train unnecessarily; many minor derailments can be rectified with ramps and packing.

(2) When it is required, calling for it immediately with precise information of the nature of the mishap. The latter enables the best formation to be marshalled before the breakdown train leaves the depot and indicates the equipment most likely to be needed for re-railing or removing the obstruction.

(3) Prompt supply of a guard to work the breakdown train.

(4) Giving the breakdown train a speedy journey to and from site.

(5) Moving any vehicles which may obstruct the breakdown gang.

To sum up: the objective of the two departments together is to move the traffic satisfactorily at least cost; the motive-power department by achieving maximum availability, particularly at times of peak demand; the operating department by most efficient utilization. Utilization is more than efficient diagramming. It includes using the engines most efficiently in traffic; loading freight trains to the capacity of the locomotive where traffic requirements permit (to capacity, not to excess—which is a rapid way to trouble); avoiding the unnecessary detention of locomotives at signals, at stations or elsewhere, and moving them quickly. Even a signal check involves extra wear on locomotive brake blocks and a considerable cost in fuel for the train to be restored to its scheduled speed.

Variations from the normal schedule call for special co-operation. The motive-power depot must be given the longest warning of train cancellations, extra trains, or locomotives likely to be late into the depot, in order that necessary rearrangements may be made. If, for any reason, it seems that the depot is likely to be unable to despatch the right type of locomotive for a train at the appointed time, the motive-power department must consult the operating department (usually the Control office) to see what is the best alternative which can be supplied.

SUMMARY

1. *Keep locomotives moving.*
2. *Move them at speed.*
3. *The capacity of a locomotive depends on how it is used.*
4. *Minimum stock—maximum availability—maximum utilization.*
5. *Specialization in design or restricted-route availability impairs utilization.*
6. *Promptly from the depot—promptly return.*
7. *Keep visits to motive-power depots to a minimum.*
8. *Reliability should be ensured by preventative maintenance.*
9. *Co-operation between operating and motive-power departments is essential.*

CHAPTER 6

Passenger Stations

THE passenger station is the place where a passenger commences or terminates his rail journey, or where he transfers from one train to another. Changing trains is an inconvenience to the passenger and has disadvantages for the operator, involving as it does an interruption of movement. How this may be reduced is discussed in Chapter 13. There are many sizes of passenger station but the main operating division is between: (1) through stations; (2) dead-end stations, or terminal stations.

THROUGH STATIONS

Some through stations have separate single-sided platforms outside the tracks, one serving the up line and one the down. Others have an island platform between the two tracks. Stations served by several tracks may have a combination of the two methods.

Comparative Merits of Single-sided and Island Platforms. Island platforms are beneficial in the following ways:

(*a*) They facilitate the quick transfer of passengers and parcels traffic between connecting trains.

(*b*) They assist in making the most economical use of staff.

(*c*) They are economical in the provision of buildings. Waiting rooms, lavatories, refreshment rooms, staff rooms etc., need not be duplicated as is often done with single-sided platforms, yet they are readily accessible. This reduces building, maintenance and cleaning costs.

The main disadvantage arises because they are interposed between the tracks. This may involve curvature of the track as it approaches the platform, and the imposition of speed restrictions may be necessary.

Bay Platforms. At through stations where trains originate and terminate, bay platforms with dead-end tracks are sometimes set into the main platforms. They enable turn-round trains to be detained without occupation of the through lines. Transference of passengers between trains on the through lines and those in the bays can be made with the minimum of inconvenience.

Halts. The halt is a simple through station (preferably without buildings) situated in rural areas and is normally unstaffed. Tickets are issued and collected on the trains. Some other through stations can be

operated satisfactorily without the employment of platform staff to cover the whole of the train service. In these cases the booking clerk must collect the tickets of alighting passengers, as needed.

TERMINAL STATIONS

At the terminal station each track usually terminates at buffer stops. The platforms are constructed in a grid formation with the concourse at right angles to the platforms and beyond the buffer stops.

Locomotive Release Lines. Unless the whole of the service is operated by multiple-unit trains, it is desirable for an additional track to be provided between the platform tracks and connected to them with cross-overs. This facilitates the quick release of locomotives after working an incoming train.

It is often desirable that the coaches to form an outgoing train should be placed in the platform some little time before the train is due to leave. In the absence of facilities to release the locomotive which worked the empty stock, it is locked in until after the train departs. This is expensive in motive-power costs. Similarly, locomotives working incoming passenger trains are trapped until the coaching stock has been withdrawn. This makes it difficult for a locomotive and coaching stock to continue to work together, as it involves undesirable shunting. In view of the stress laid on keeping locomotives and coaching stock moving, discussed in earlier chapters, an arrangement whereby the two work together is often desirable. From the point of view of station working this has the advantage that movements are reduced to a minimum.

Circular Loops. The waste of time involved in the reversal of trains at dead-end platforms can be avoided by the elimination of dead-end lines and the provision of a loop passing under the concourse. It is not a method employed in Great Britain but there is such a layout at Grand Central Station, New York (see Fig. 12). This type of layout also reduces conflictions between up and down trains, which is always a feature of terminal working.

EFFECT OF PASSENGER STATIONS ON LINE CAPACITY

In Chapter 2 various factors affecting line capacity, such as signalling methods, length of block sections, speed of trains, etc., were mentioned. A most important additional limiting factor on the capacity of a line is the capacity of the passenger stations. Signalling and train speeds may permit trains to move over a section of line with brief headways, but this is of no avail if the stations for which the trains are destined have no platforms available to receive them at the appropriate intervals. Stations must be equipped with an adequate number of platforms but

PLATE 13. *First-class compartment on electric multiple-unit stock used by the Southern Region. Plate* 15 *shows second-class accommodation on the same train.*

PLATE 14. *First-class open saloon, diesel multiple-unit Pullman coach (London Midland Region). The saloon is air-conditioned and insulated against noise.*

PLATE 15. *Second-class open saloon, electric multiple-unit stock used by the Southern Region. Open saloons provide more seats per vehicle than do compartments.*

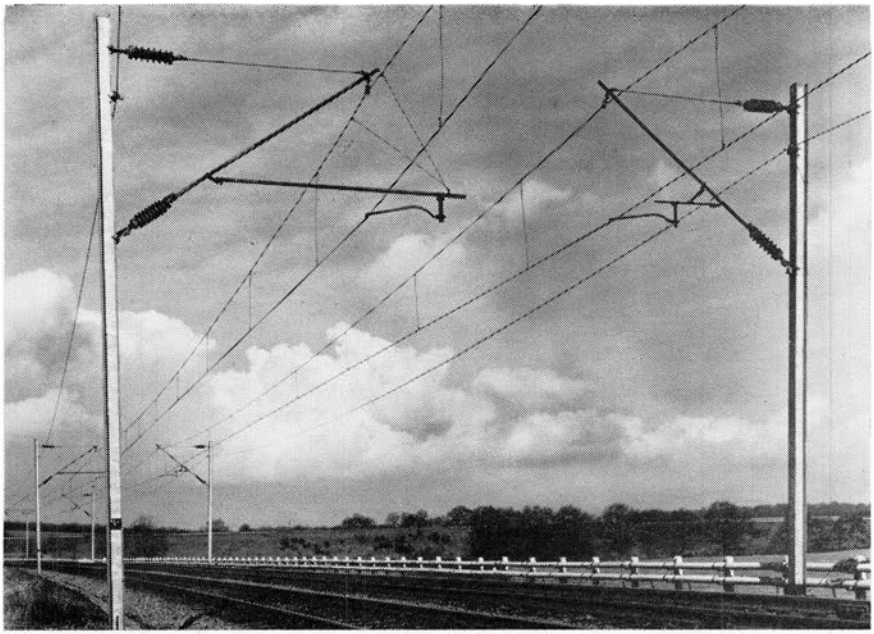


PLATE 16. *Overhead structures and wiring for electric traction* 25,000-*volt a.c. lines. Note the lighter construction as compared with the illustration below.*

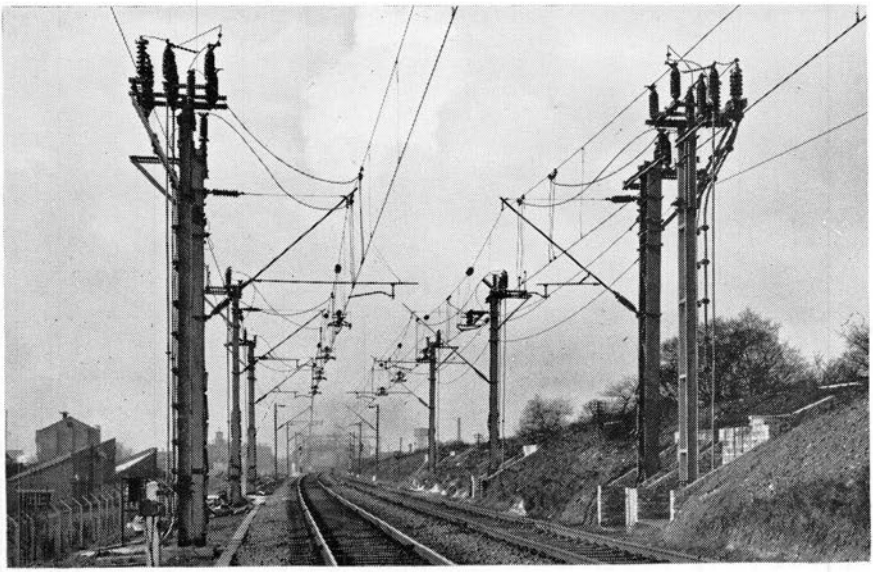


PLATE 17. *Overhead structures and wiring for* 1,500-*volt d.c. lines.*

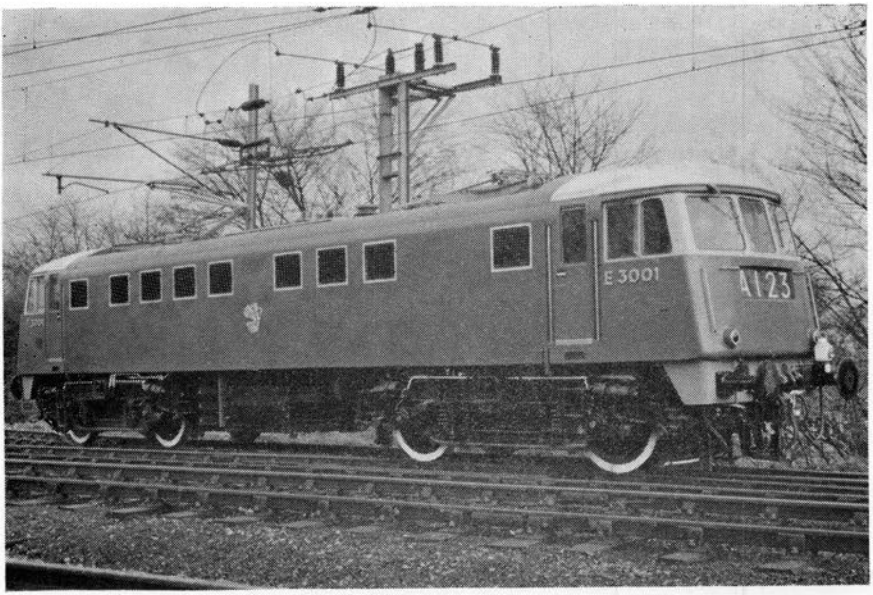


PLATE 18. *Electric locomotive*, 25,000 *volts a.c., used on the London Midland Region.*

PLATE 19. *Electric locomotive*, 630/660 *volts d.c.,* (*Southern Region*) *taking current from a third rail.*

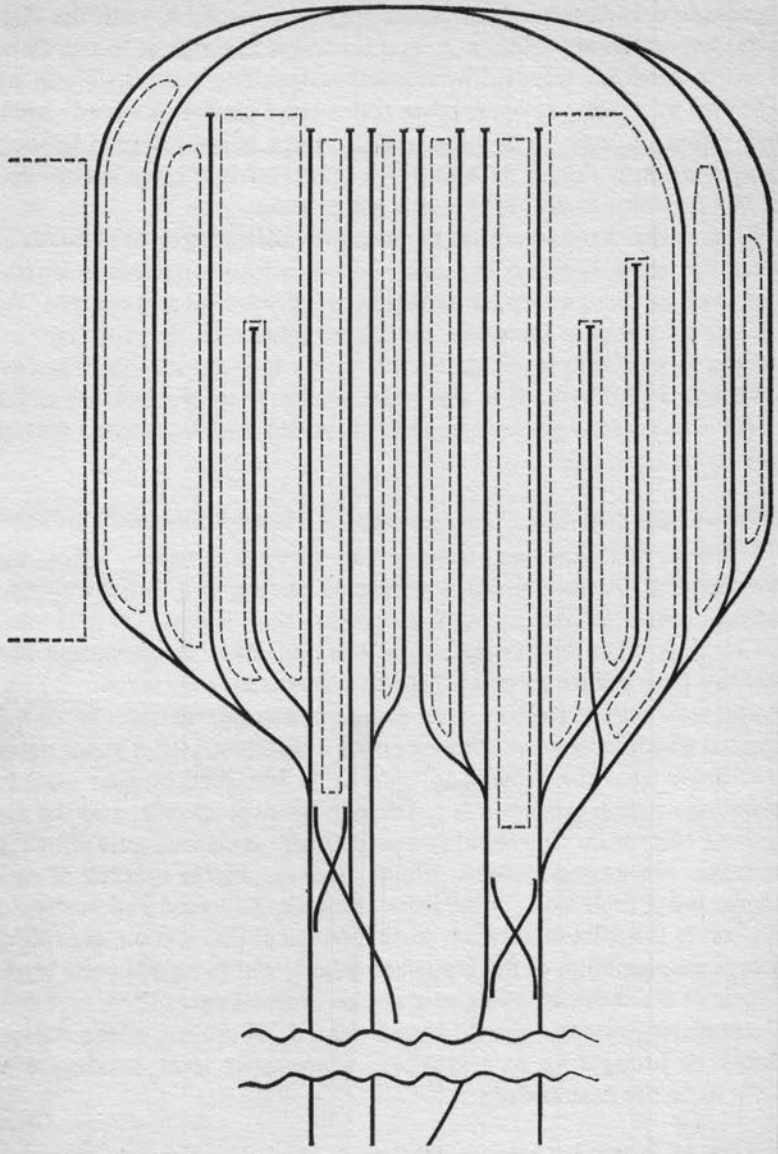


FIG. 12. *Platform lay-out at Grand Central Station, New York.*

difficulties may still arise if platform tracks are used for storage instead of for transit purposes. If they are used for stabling parcels vans, coaches, etc. unnecessary difficulties may be created. Even if the platforms concerned are sufficiently long for trains to continue to use them, entering trains are retarded by restrictive signalling aspects. These are exhibited as a safety measure when trains enter platforms already occupied. When a train terminates, and the stock is not required to form another train, it should be withdrawn immediately if there is any need for the platform to accommodate another train.

On the other hand, there are perils in providing platforms in excess of operating needs as this is expensive and may lead to inefficient operation, such as the unnecessary detention of locomotives and coaches. As the size of a station increases, the inconvenience to the passenger increases, especially in reaching the remoter parts of the station. The cost of staffing a station tends to rise in proportion to its size because of the longer time taken to get from one job to another and because of a greater area to be kept clean.

Effect on Line Capacity: Reducing stops at Through Stations

The time taken for each train to pass through a section affects the line capacity. A train which is scheduled to stop at a through station requires longer to pass through the section than it would if scheduled not to stop. The first contribution one can make to maximum line capacity is to reduce stops at through stations to a minimum. Trains should stop only if there is good cause. When new services are being planned which have no existing or previous counterparts, it is necessary to estimate what the demand is likely to be at a particular station. In reviewing existing services it is possible to be more specific, and the use made of every train stop should be periodically examined, guided by the passenger census and analysis details. These show the number of passengers using each stop. Where the use is small, consideration should be given to the train in question ceasing to call at that station, providing there is no possibility of the usage being increased to an adequate level. If none of the trains stopping at a station are well patronized, methods of stimulating demand should be considered. If the use of the station cannot be brought up to a satisfactory economic level, its closure is likely to be the best answer.

Problem of Important Junction Stations

The most common places for delays to occur are at the approaches to important stations where the rail intersections are on the flat. This is not surprising considering that:

(1) Here the services of several lines converge at one point.

(2) Many train movements conflict.

(3) A number of trains stop to provide connections or for other purposes.

(4) The duration of some stops is prolonged to permit connections between several trains.

(5) The number of shunting movements—which also conflict with certain running-line movements—are likely to be numerous owing to interchange of vehicles between trains, and for other reasons.

The planning of the work at these key points on the line merits special attention. If the construction of tracks on more than one plane can be justified (i.e., by making fly-overs or burrowing under lines) this will make the best contribution to the increasing of line capacity and the elimination of delays. The control of signalling from a single power-worked box is of considerable benefit, and it may help further if two-way working is permitted on certain lines. If flat junctions must continue, a systematic allocation of trains to the various platforms—bearing in mind incoming, shunting and outgoing movements—can reduce the number of conflictions. The changing of train locomotives and light-engine or empty-coaching-stock movements aggravates the difficult situation that exists at busy junctions and should be avoided as far as possible. After analysis, it may be possible to avoid these movements and this is likely to lead to an improvement in efficiency. If station stops are necessary, those of short duration will reduce line capacity less than longer ones. They should be scheduled for the minimum period commensurate with the work to be done.

Service Stops. A train may stop at a station for reasons other than for passengers to join or alight; e.g., for a locomotive change, for train crew relief, for a steam locomotive to take water, etc. From a line-capacity point of view it is better if service stops can coincide with those for passengers, to reduce the total number of stops required. Even when they do coincide they may cause the duration of the stop to be extended, and intermediate servicing of this kind should be avoided if practicable.

Platform Loops. Additional running lines may be provided at through stations to permit trains to stand at the platform without obstructing the main lines. They are particularly useful where trains terminate or originate, or if certain trains are obliged to stand at the platform for prolonged periods. If used to permit a non-stopping train to overtake a stopping one they are likely to involve the latter in a wait of several minutes.

Effect on Line Capacity: Terminal Stations

The capacity of the terminal may determine the number of trains

which can be run. There must be sufficient platforms to accommodate trains, but it is not only a question of platform availability. The number of running lines approaching a terminal is normally less than the number of platform lines. At some terminals the number of running lines is less than the operator would desire, but to increase it would involve prohibitive cost. As arriving and departing trains travel between the running lines and the platform lines some conflicting movements are unavoidable, and the capacity of the approaches to the terminal may be the restricting factor on the number of trains which can be run.

The availability of platforms depends not only on how many there are, but on how they are used. Quick turn-rounds are the basis for maximum utilization and the use of multiple-unit trains is helpful in this connection. A single platform may accommodate more than one train, but when this is done it is necessary to ensure that a train or vehicles are not blocked in at their departure time.

The approaches should be laid out and signalled to keep conflictions to a minimum, and the planning of the time-tables and allocation of trains to platforms should have the same aims. Unnecessary movements should be avoided, in particular light-engine and empty-coaching-stock movements should be kept down. The use of incoming trains to form outgoing services is the best means to this end. The employment of multiple-unit trains reduces the movements required.

At peak times it may be necessary to reduce the number of trains into and out of the terminal. This may necessitate diversion of trains to other stations or terminating them short of the main terminal and conveying passengers forward by other means; e.g., by underground railway or by roads. These courses may impose some inconvenience to passengers, but to attempt to run trains in excess of the capacity of the facilities can only lead to congestion and delay; these are likely to prove an even greater inconvenience.

THE PLAN OF STATION WORKING

Planning the work is not only essential to permit the maximum number of trains to run between stations punctually, it is also a prerequisite to the efficient operation of a station, to reducing the staffing costs and to ensuring the well-being of the passenger.

A new station working plan is normally introduced with each new time-table. The plan may be published under the title of Station Working Booklet or Platform Working. In some places they are called Simplifiers as they bring together the information shown in the working time-tables, diagrams etc., as well as indicating the allocation of trains

to platforms, and show the whole of the information concerning a particular station in a simplified form.

Planning Passenger Movements

As well as avoiding unnecessary conflicting train movements, the plan must also reduce to a minimum conflicting movements of passengers. Certain defined flows of passenger movement will occur, for instance: (*a*) from the booking hall(s) to train departure platforms; (*b*) between connecting trains; (*c*) from arriving trains to the station exits.

As far as possible these flows should be so arranged that no conflicting movement takes place otherwise passengers will be inconvenienced and the slowing down of movement may result in congestion and possibly train delays. Walking distances should be kept short for the same reasons, and this may be achieved by proper allocation of trains to platforms. Once the plan is in operation, attention should continue to be given to reducing walking distances. For example, drivers should bring their trains to a stand in a position which keeps walking to a minimum.

Some of the planning of the station working at main terminal and junction stations must proceed concurrently with the preparation of the working time-table, as precise arrival times often cannot be established until it is known which platforms are to be used for particular trains. At stations with some short platforms, care needs to be taken to allocate trains to platforms of sufficient length to accommodate them. However, some of the more detailed planning can be done after the preparation of the time-table is complete.

Information contained in Station Working Plan

There is no standardized form of plan, but the document setting it out may include the following details:

Arrivals	*Departures*
Description of train	Description of train
From	To
Time due	Time of departure
Approach line to be used	Platform
Platform	Departure line to be used
Next working of locomotive	Worked by locomotive off
Next working of coaching stock	Worked by coaches off
Next working of driver	Worked by driver
Next working of guard	Worked by guard

Uses of Station Working Plan

Once the plan has been drawn up it should be communicated to all

staff concerned and steps must be taken to ensure that each person understands the plan and the part he is expected to play in carrying it out. Porters, shunters, signalmen, inspectors, carriage examiners, and various other grades require copies of the plan. It is also the basis for the train departure and arrival information which is exhibited for the benefit of the public and passengers.

Modifying the Plan. After much effort has gone into drawing up a sound plan, it is sensible to adhere to it strictly. This helps regular passengers and results in more efficient working. However, there are occasions when variations are unavoidable:

(*a*) *When trains run late or mishaps occur.* If a train fails to arrive at its booked time, it may require to be diverted to a different platform because its scheduled track is occupied by a later train. Switching is complicated if some of the platforms concerned are short and some of the trains are long. To give more flexibility it may be desirable to restrict the length of all trains to permit diversions into some of the shorter platforms. Point failures or other obstructions to movement also require current adjustments to be made. In making adjustments the convenience of passengers must be an important consideration, and great care is needed to ensure that all concerned, public and staff, are made aware of the revised arrangements. At busy stations the reaction set up by platform adjustments is likely to continue for some time, but the normal working arrangements should be restored as soon as possible.

(*b*) *When additional trains are run.* Additional trains are usually arranged some time in advance and it is better if they can be accommodated without disturbance to the platforming of the regular trains. If this is not possible, alterations should be only those which are unavoidable, and all staff and the public need to be advised of the temporary arrangements which are to operate. Heavy programmes of additional services may necessitate a special issue of the station working arrangements booklet to cover the period concerned.

STATION SHUNTING

Shunting may be done by shunting locomotives or by train locomotives. If the latter have long turn-rounds it may be economical to use them although they are not specifically designed for this purpose. If an incoming train is late and the locomotive is scheduled to do the shunting, the shunting is likely to be delayed, which could result in late departures.

If the employment of shunting locomotives is justified, diesel locomotives may be more economical because of single manning, cheaper

fuel costs and so on, but if preheating of coaching stock is required from the shunting locomotive a steam locomotive may be preferable. However, steam locomotives have the additional disadvantage of soot emission. Periodical analyses of the work done and standing time of shunting locomotives should be made to see if reductions can be effected in the hours which they are employed. The introduction of multiple-unit trains often reduces shunting work considerably. It may permit reductions to be made in shunting locomotive hours and also in the number of shunting staff employed.

COMMUNICATIONS

The smooth running of a passenger station depends on adequate communications. The plan of operation just mentioned has to be communicated to all the staff who are required to carry it out. A knowledge of part of it is required by the passengers. This can be done through printed notices. It is helpful if these are supplemented by oral communications as the passenger is then relieved of the trouble of finding and reading the notices that contain details of train times, destinations and platforms to be used. If the plan has to be amended, verbal communications can be passed more quickly to more people than can be done by written notices, but if both can be used there is less risk of misunderstandings.

The methods used to communicate information include:

(*a*) *Loudspeaker systems.* A good broadcasting system is a valuable aid in the speedy dissemination of information. It is desirable for the announcer to have a good view of the station. He or she should be able to switch in and out particular sections of the system, and should select the particular sections which require individual announcements. This avoids passengers being subjected to irrelevent announcements. Loudspeakers may be used for:

(1) Giving train departure and arrival details.

(2) Requesting passengers' co-operation on various matters; e.g., asking them to join the train and close the doors just prior to departure time.

(3) Explaining the cause of late running and apologizing for it.

(4) Contacting individual passengers or members of the staff.

(5) Advertising railway facilities.

(6) Making other miscellaneous announcements.

(7) Transmission of music between announcements.

Announcements should be easy to hear. This depends on the type of equipment employed and the correct siting of loudspeakers. Careful selection and training of announcers is important. Announcements

should also be easy to understand, courteous and brief. This is most readily achieved by advance preparation of a script for routine announcements. This need not preclude announcers using their initiative when circumstances demand it. Routine announcements may be recorded. In certain cases they are set up in sequence and the appropriate announcement is operated by the approach of the train. Such apparatus needs to be capable of switching over to live announcements when the time-table breaks down for any reason.

(*b*) *Transistorized hand megaphones.* Light, battery-powered hand megaphones are useful at some stations where the expense of a fixed loudspeaker installation cannot be justified.

(*c*) *Verbal directions* from enquiry clerks, ticket collectors, porters etc., are required to supplement amplifying apparatus, and where none is provided they must take its place to a degree. It is imperative that staff do not give wrong information. In cases of doubt or when they do not know the answer, they should whenever possible find the information themselves and let the passenger know rather than refer him to a third party.

(*d*) *Printed Notices.* Relevant extracts from the time-tables should be exhibited at convenient points to reduce the number of verbal enquiries. They should be well illuminated and set out in a form which is easy to understand. Details of departures and arrivals may be printed on sheets or revolving blinds. They may be displayed on illuminated indicators or shown in other ways. Various other printed notices may be required, but the display of too many is likely to result in a widespread disregard of them. The minimum number properly sited and tastefully designed produces the best effects.

(*e*) *Written notices* may be required to advise passengers of information that has just been received. Blackboards are sometimes used for this purpose. Care should be taken that the writing is clearly legible, and if possible a member of the staff who has a flair for good handwriting should compile them. As soon as they cease to apply they should be removed. For special announcements that recur, such as advices of delays on account of mishaps, a partly printed notice is to be preferred, which has a space for insertion of particular information; e.g., location of mishap.

(*f*) *Television.* Closed-circuit television is sometimes the best way of disseminating information to several points of the station concurrently. For example, if the details of time-keeping of approaching trains are received at the station signal-box, television may be the most efficient method of transmitting them to the various people concerned—platform staff, enquiry clerks, joining passengers and so on.

LOOKING AFTER THE PASSENGER

In Chapter 1 the need for trains to convey large loads was emphasized. With passengers, this means a train-load of hundreds. Yet the attraction of competing forms of transport is the amount of attention given to the individual. The art of running a passenger station is to deal with hundreds and possibly thousands of people, and at the same time to give satisfaction to the individual passenger, however difficult this may be.

Siting of the Station

The station should be easy to find. It should be well situated in the town and have good access. Direction signs at strategic points in the town should indicate its position, and the elevation should assist its recognition. The architecture should be in keeping with its setting and generally pleasing, but with existing stations it is often a case of making the best of what is already there. Interchange with bus services can be arranged with the least inconvenience to passengers if the bus terminal or bus stop is immediately adjacent to the station.

Car Parks

Most passengers are motorists who prefer not to use their cars for the particular journey they are making. They are likely to be able to make the quickest overall journey if they can use their cars between home and station, and be assured of a place to park at the station. As the number of cars is still increasing, efforts must continue to extend parking space, either on the surface, in tiers, underground, or on the station roof. A petrol-filling station is a useful facility and the rent paid for the concession can be set against the cost of the car park.

Reception of Passengers

A space for setting down passengers from cars and taxis should provide covered access to the booking hall; at main-line stations—porters need to be available at this point. As there are peaks and quiet times in arrivals at the station it is difficult to regulate the number of porters to supply all passengers who require them and to avoid undue wasted time of the porterage staff. At some main-line termini porters are permitted to assist passengers with luggage, outside their official working hours, to earn further gratuities. As they are not paid for the additional time this is a cheap way of getting the job done, but the sight of too many staff gives the public a bad impression.

The provision of light-weight trolleys to permit passengers to take their luggage to the train may help when the porterage staff is not adequate to meet demands. The Continental system, where the railway authorities grant a monopoly permit to a private syndicate to do the porterage work, has merit.

Booking Hall and Office

The booking hall is a good location for the enquiry office as this will reduce the number of enquiries received at the booking-office window. The important thing is to permit the passenger to book his ticket without delay, but this again is made difficult at peaks. If some queueing is inevitable at peak times, the design of the booking hall should permit this to be done without impeding general movement. The following methods help to eliminate delays to passengers in the booking hall, and a combination of them may be applied at particular places.

(*a*) *The provision of more than one booking office.* This is particularly useful—where there are several entrances to the stations—in reducing passengers' walking distances and avoiding cross-flows. This method may be more expensive in staff and more inconvenient from an accountancy point of view than having a single office.

(*b*) *The provision of more than one booking window at a booking office.* Where this is done it is desirable that a passenger should be able to book at any of the windows, but divisions are sometimes necessary. This is usually done by an alphabetical arrangement, according to the first letter in the destination station name. Sometimes there are separate windows for first- and second-class tickets, and for season tickets (see Plate 22).

(*c*) *Mechanization of ticket issuing and change giving.* Mechanization takes various forms, including coin-operated machines which avoid the use of the booking window altogether. These machines can be used only for a limited range of stations or fares.

(*d*) *The issue of multi-journey tickets.* Return tickets, season tickets and other similar tickets have the advantage that the passenger does not need to use the booking office at the beginning of each journey.

(*e*) *The issue of tickets on trains.* Conductor-guards are employed in places to issue tickets on trains. They are normally employed on trains which call at halts.

(*f*) *The issue of tickets by agencies and booking offices in advance of travel.* Tickets bought at agencies obviate the use of the booking office. Tickets ordered from the booking office through the post have the same advantage. Advance booking at a booking office enables passengers to buy tickets at slack times instead of busy ones.

MOVEMENT OF PASSENGERS THROUGH THE STATION

Passengers should be enabled to pass through a station in the shortest time without discomfort. They need clear indications of the location of departing trains. Apart from the destination indicator, the names of all the stations served by each train should be displayed on the platform in a prominent position and, if possible, the destinations served should be shown on the train itself. Visual information should be supplemented by verbal announcements where this can be arranged. Already the need to avoid conflicting movements and to reduce walking distance has been emphasized. In addition, passengers' movements should not be impeded by badly sited obstructions; e.g., pillars, kiosks, etc., or by barrows and other mobile equipment left in their path. There is some merit in keeping parcels and similar traffic out of passenger stations. This is discussed later. Travalators (moving platforms), escalators, lifts and other mechanical devices may help to speed passenger movements.

Platform barriers which are used to facilitate ticket inspection and collection and also to assist in getting punctual departures, are the bottlenecks through which many passengers pass, and it is at these points that congestion is most likely to occur. This is a greater problem with passengers who have just alighted from trains than with passengers for departing trains, as the latter arrivals tend to spread over a period. Congestion can be eased by the use of open platforms (i.e., without barriers) when ticket collection or inspection is done by travelling collectors. Ticket examination or collection *en route* has the added benefit that passengers travelling in a class higher than that for which they hold tickets are detected more readily. When working on trains, ticket collectors are not employed so productively as when they are engaged at platform barriers, particularly when the trains concerned make only infrequent stops. This increases the cost of revenue collection. Ticket duties can be effectively carried out on trains only when they have corridor vehicles and access between all vehicles. It is difficult to do this when trains are crowded with standing passengers.

An adequate number of ticket collectors at barriers is essential to minimize the delay in passing through. They should be selected carefully and trained thoroughly as they require to be tactful as well as quick and efficient in the performance of their duties. Where there are numbers of excess fares to be collected it is desirable for a separate collector to be allocated to this task. This arrangement caters for passengers who alight without tickets, or without proper tickets,

and at the same time does not slow down the movement of the other passengers through the barriers.

Taxi Stands. The passengers alighting from incoming trains may require taxis. Because trains may convey several hundred people, the demand is likely to be heavy for a short time. The first requirement is the issue of an adequate number of permits to use the station stands. Secondly, it is important to provide sufficient parking space for taxis to assemble before the arrival of a train. If this space is out of sight of the hiring points some communication between the two places is required, to inform the taxi drivers when they may approach the hiring points. Thirdly, several hiring points are desirable to facilitate quick loading and despatch.

PASSENGER AMENITIES

Station Name Signs. It is customary to provide large name signs at the incoming end of platforms, supplemented by small signs along the length of each platform. *Direction signs* are needed to indicate the situation of the Left Luggage Office, Tea Rooms and so on.

Waiting Rooms. The constant aim in the operation of passenger services should be to make the provision of waiting rooms unnecessary—by keeping passengers on the move. Until these aims are achieved and to cater for passengers who arrive ahead of train departure times, waiting rooms are required and should be pleasantly appointed, preferably with central heating and certainly clean. At some places it may be desirable to combine them with refreshment rooms.

Refreshment rooms should be provided where the demand justifies it. They may vary from snack-bars to restaurants. There is some advantage in having direct access from the highway as well as from the station, as the general public may help to maintain revenue levels at off-peak times.

Left Luggage Depositories. One of the problems encountered here is similar to that already mentioned with platform barriers. The arrival times at the station of travellers wishing to collect luggage left at the depository and to commence their journey tends to spread over a period. Passengers alighting from trains and who wish to deposit luggage, arrive at the depository in considerable numbers at about the same time, and queueing is involved. Two methods of dealing with this are:

(1) The provision of coin-operated left-luggage lockers. As passengers deposit their own luggage, queueing is eliminated. These lockers have the additional advantage of economizing in manpower and being available 24 hours a day. At staffed depositories it is often uneconomical

for them to be open continuously. The main disadvantage arises from passengers losing keys. When this happens it is necessary to change the locks to ensure the security of future deposits.

(2) To collect charges when luggage is collected rather than when it is deposited. This enables the queues of depositors off incoming trains to be dispersed more quickly.

Lavatories. At the larger stations it is possible to justify the employment of attendants. Whether attendants are provided or not, it is desirable for lavatories to be inspected and cleaned, as necessary, frequently throughout the day, in addition to the main daily cleaning.

In addition to railway-owned amenities, other passenger facilities are provided by railway tenants. Bookstalls, kiosks, shops and so on benefit the passenger and the rents paid contribute revenue to the railway.

Location of Amenities. At through stations, other than those with a single island platform, it is common practice to have waiting rooms, refreshment rooms, lavatories, etc. on each platform. This increases costs, but if they are located on one platform only they may be too inaccessible. To overcome this difficulty, a design which provides for the location of the amenities on an over-line bridge, with convenient access to each platform, has advantages.

Cleanliness and tidiness of the amenities and of the whole station are important. At larger stations a degree of mechanization such as platform-sweeping machines may be justified. Although lavatory and waiting-room attendants may be employed at some stations, it is economical to use up unproductive time of platform staff for cleaning the station. All the duties should be rostered for performance at appropriate intervals, allowing sufficient time for each cleaning operation to be done thoroughly. Allocation of duties should be clearly defined, so that if the work has not been done satisfactorily the responsibility can be apportioned and action taken. Some may assume that modern stations are easier to keep clean than older ones; this is not necessarily so. It is true that simplicity in design assists cleaning, but owing to the increased use of glass this may be more than counterbalanced by the work needed to keep it clean.

The co-operation of the public needs to be sought in keeping stations tidy. If they find the station clean when they arrive they are more likely to respond well than they would to one in a dirty condition, so the initiative rests with the station staff. An ample number of litter bins should be provided in conspicuous places; they should be emptied frequently.

MODERNIZATION OF STATIONS

The aim should be to make stations as bright and attractive as possible. Maintaining the good appearance of antiquated stations is a difficult task, and dingy surroundings may cause the staff to become discouraged. Many stations need modernizing, but it is not always easy to ensure a return on the capital invested. Modernized stations do not as a rule produce substantial increases in the number of people travelling. Therefore, in planning station reconstructions one must try to design them so that reductions in working costs will result. If the work of two or more stations can be combined in one modernized station, substantial economies may accrue and the service to the public may be improved at the same time. Increases in revenue may result from modernization if it produces more accommodation to be let to tenants, or, if existing tenants can be required to pay more after their accommodation has been improved. It may also come from increased parking facilities, catering receipts and so on.

Although a modernized station should be an integral part of the local landscape there is scope for standard constructions for particular units such as waiting rooms, shelters, staff rooms etc. If such standard units are employed it is likely to reduce building costs. Even if an adequate return on capital is not likely to be obtained, modernization may still be justified for prestige or other reasons. As railway stations have the nature of public buildings it could be argued that it would be right to ask local authorities to share the cost of station improvements. The station is often the first place seen by visitors and must influence their opinion of the locality.

COURTESY

Many of the items already mentioned in this chapter are a form of courtesy, and all that come under the heading *looking after the passenger* are most important; for example, the avoidance of delays, a clean and tidy station, and so on. But these may pass unnoticed if the passenger is treated rudely by a member of the staff. Conversely, some form of bad service may be overlooked if the passenger is treated as the important individual that he is. Without passengers there is no need for the station, the staff or the trains, and this thought should be uppermost in the minds of all concerned. It is in the selection of staff and in their training that courtesy can be best established. No job which involves contact with the public should be the " right " of a railwayman unless he can behave courteously to the passengers. Positions such as ticket collectors do not demand such high standards of physical fitness as

other railway jobs, but it would be wrong to fill these posts with less fit men regardless of their courtesy standards.

PARCELS AND SIMILAR TRAFFIC

At many passenger stations, parcels, mails and other traffic which is conveyed by passenger or parcels train are handled. The working of this traffic is described in Chapter 13. From the point of view of station working there are a number of unsatisfactory features in dealing with passengers and parcels on platforms common to both. Each type of traffic tends to impede the other, and parcels may be exposed to theft. In consequence, there are advantages in concentrating much of the parcels traffic at separate parcels depots, but some parcels traffic is likely to continue to pass through the passenger station.

The exchange of parcels between platforms or between street and platform often involves movement between different levels. The use of lifts or hoists causes some interruption to movement, and where ramps can be provided they may be preferable. A station may have to handle *transhipS* as well as *forwarded* and *received* traffic. Those parcels which require documentation normally pass through the parcels office. They pass between the trains and the parcels office by truck or barrow. Those not requiring documentation may be loaded directly between road and rail vehicle, or sometimes they are transferred by truck. Where possible, conflictions between parcel movements and passenger movements should be avoided.

REDUCING STAFF COSTS

Much of the expense of running a passenger station is absorbed by staff wages. If a reliable and efficient service is to be given at the least cost, the following points must be considered:

(1) Traffic varies from day to day. If increases, particularly in parcels traffic, are not to cause delay, the number of staff employed must be adequate to deal with trains on the busier days, within the time allowances. It may be desirable for the staff to be augmented at times of the highest peaks; for example, in the pre-Christmas period when parcels and mails pass in greater volume.

(2) An analysis of working methods must be made to ensure that staff are being deployed in the most efficient manner. In illustration of this, consider the transfer of parcels between a rail vehicle and a platform truck. Normally, the most economical method is for one man to be employed per platform truck. If two or three are engaged the number of parcels handled per man, in a given period, decreases owing to staff obstructing each other, and also to the waiting time when parcels

are passed from hand to hand. If the problem is to deal with a train in the shortest time, and the loading and unloading of parcels is the determining factor, it may still be necessary to employ more than one man per truck in spite of the reduced productivity. But there is no advantage in increasing the size of a gang above three persons, as this normally tends to slow down the transfer process.

(3) It is necessary to ensure that sufficient staff are booked on duty at the work peaks; these do not necessarily coincide with the train peaks. Although one man may be able to deal satisfactorily with certain trains, to deal with other trains may call for several men. Trains with a number of parcels vans to be dealt with in a short time may need the attention of several people. After the station working plan has been completed it is possible to calculate how many men are required at any one time. This enables the minimum establishment to be calculated. At the same time, the work peaks are indicated and the rostering should provide for maximum availability of staff at these times.

(4) In planning the staff duties, the most economical and flexible working is achieved where there is the least number of demarcation lines between the duties of the men concerned. Parcels porters should be used for other duties during the time they are not required for parcels traffic. They should be assisted by other staff during the busiest periods of parcels traffic handling. Where unnecessary division of duties have been allowed to arise, they should be broken down as opportunity permits. Similarly, men should be transferred between platforms as necessary but in planning their work it is essential to bear in mind the possibility of trains running late and to cater for this contingency as necessary.

(5) Walking distances for staff and trucking distances with parcels traffic must be kept to a minimum. Unnecessarily large stations tend to increase these, with consequent loss of efficiency.

SUMMARY

1. *Unnecessarily large stations increase costs and impair efficiency.*
2. *Terminal-station capacity may govern the number of trains which can be run.*
3. *Quick turn-rounds enable the best use to be made of available platforms.*
4. *The number and duration of train stops at intermediate stations may govern line capacity. Keep them few and short.*
5. *The approaches to important junctions and terminal stations are critical points. The number of movements there should be kept down.*
6. *The passenger is the important person for whom the station exists.*

CHAPTER 7

Freight Terminals

EXCEPT where a railway siding in a trader's premises (a private siding) or one adjacent to them (a rail-connected tenancy) is used, every consignment travelling by rail must start and finish its journey by road. This transfer places the railway at a great disadvantage as compared with road transport in relation to both journey time and cost, and every method of reducing this disadvantage must be sought. The terminal is the place where the traffic is transferred from road vehicle to rail vehicle or vice versa. It may also be referred to as a goods depot or a goods station.

AIMS IN GOODS TERMINAL OPERATION

The three main problems in goods terminal operation are: (*a*) the interruption to the movement of the goods which extends over-all transit times; (*b*) the considerable expense of operating a terminal; a proportion of these costs have to be borne by each consignment; (*c*) the risk of damage which is always present when goods are handled. The main aims, therefore, must be to avoid these perils and to: minimize delay; reduce the cost of operation to the lowest figure; and to avoid damage. These objectives can best be reached by keeping traffic moving and reducing to a minimum the distance to be moved and the time taken. There should be the least handling possible, therefore unit loading should be used if practicable. A further measure is to keep down unladen movement of men and machines. Success depends on location and design of the depot, method of working, type of equipment used and on staff who use it. Each factor must be considered, but first it is necessary to specify the types of traffic to be dealt with.

TYPES OF TRAFFIC

The traffic may be divided into three main groups. Traffic received by rail for delivery by road is referred to as *inwards* or *received* traffic, and that brought in by road for despatch by rail as *outwards* or *forwarded* traffic.

Wagon Load Traffic

This is traffic from one sender to one consignee which has the exclusive use of a rail wagon or container between terminals. It does not

necessarily occupy the full weight or cubic capacity of the wagon, but either the weight of the consignment or its nature influences those concerned at the sending point to consider that the best means of dealing with it is to allocate a whole wagon for its conveyance.

Part Wagon Load Traffic

Where traffic from two or more consignors for a common destination can be combined it is called part wagon load traffic. The joint use of the wagon leads to reduced costs for wagon provision, and the advantages of good wagon loading set out in Chapter 3 apply.

Less than Wagon Load Traffic (*Sundries*)

This group consists generally of the smaller items which, during their rail journey must of necessity share the use of a wagon with other goods. In some places they are called smalls, but as small is a relative term it is preferable to call them sundries. If this conjures up in the reader's mind a miscellany of all shapes and sizes, this is the correct impression, for sundries traffic may vary in weight from a few pounds to several hundredweights and an extremely wide range of commodities is embraced. Many articles are irregular in shape; some are packed, but others are unpacked. These variations, and the fact that some goods are more susceptible to damage than others, pose many problems.

In addition to forwarded and received sundries traffic, certain terminals deal also with *transhipS*. These are sundries which are received by rail and are then reforwarded by rail. TranshipS arise when a sending station is unable to assemble sufficient sundries to justify a through wagon to a particular destination. In this case sundries for several destinations which are situated in a common direction may be combined and the wagon sent to a suitable point for transhipping. Thus a wagon may be received at a tranship terminal containing some sundries for delivery and some for re-forwarding by rail. Intermediate transhipping not only increases the cost of dealing with a consignment but also extends its transit. It should be avoided when it is practicable to do so. One method is to consign wagons to specific destinations, which have only small quantities of traffic, on alternate days or perhaps once a week.

LOCATION, TYPES AND LAY-OUT OF TERMINALS

The terminal should be located so as to minimize cartage distances, taking into account also the effects of urban road traffic congestion. It should be as close as possible to the marshalling yard to eliminate or reduce the length of rail feeder services between the depot and the yard. The feeder service is one of the most expensive operating activities, and

unduly long ones may affect the transit time. Although the ideal method is to operate trains between one goods depot and another, it is often necessary for wagons from terminals to pass through marshalling yards, to be combined with the traffic from private sidings and from other terminals. The ideal site in relation to cartage considerations or those of train working may not be available, and a compromise is often the result.

Some terminals deal only with wagon-load traffic or with sundries but others combine the two functions. Certain depots deal only with forwarded or only with received traffic, while others are confined to certain commodities; e.g. received coal. There are variations in size and lay-out. The larger depots have a number of advantages which are discussed later under the heading *Concentration.*

Lay-outs should be free from obstructions as far as possible. Roof spans should be wide thus minimizing the number of supports required, and the fewest supports for lighting should be used. Mobile lifting apparatus is preferable to fixed cranes on this account, while the overhead crane may cause less obstruction than the mobile apparatus.

The goods yard is the place where wagon-load traffic is dealt with. Normally it is not covered but it may be desirable for a section to be provided with a roof, for dealing with traffic which is susceptible to damage by wet. In order to economize in space the rail sidings are normally arranged in pairs. The roadways between them should be sufficiently wide for vehicles to manoeuvre without impeding each other. Most of the roadways should be at rail level but loading docks or platforms, level with the rail-wagon floors, may be required for loading and unloading vehicular traffic. For the tipping of loads from road vehicles into rail wagons a higher platform is needed.

The goods shed is where the sundries traffic is sorted and transferred, although at some depots where perambulation of outwards sundries takes place this operation is done in the goods yard. It is customary to segregate sundries and full load traffic where this happens. The shed contains a covered platform at wagon-floor level, which is situated adjacent to the sidings. The platform extends from the wagon side to the cartage front where the cartage vehicles can stand alongside it. The design should provide for the easy release of wagons after they have been unloaded and their replacement by other loaded ones, without interruption to the work of the goods handling staff. At many stations the railway authorities provide warehouse facilities, which are used more often for traffic received by rail than for traffic to be forwarded.

The warehouse is often above the goods shed. Sometimes it is a separate building of more than one storey. In each of these cases a lift

or hoist is necessary for transfer of goods between floors. A single-storey building with a platform at wagon-floor level is more expensive in ground space but the most economical to operate. Berthing for cartage vehicles is required.

METHODS OF WORKING—WAGON LOAD TRAFFIC (FREIGHT)

The loading or unloading process and the conveyance by road (cartage) to or from the customer's premises may be done by railway staff and vehicles, by agents or by the customers' own employees and vehicles according to the terms of carriage, and local practice. Where the work is done by other than railway staff, the latter may be required to assist or to check quantities and condition of goods.

Unit Loads. Consignments consisting of a number of small articles which are neither in containers nor on pallets have to be moved by hand. This process contributes to the inherent dangers of delay and damage, and increases the cost of operation. It is necessary to strive for the increased use of pallets, containers, demountable wagon bodies or any other kind of unit load, which permit a load to be transferred between road and rail vehicles in the minimum time at the least cost and without individual handling of the packages. At the same time it is necessary to seek the most efficient methods of transfer of the unit loads between road and rail vehicle. Choice of equipment should be made only after a study of the work to be done.

Containers are a type of unit load. They enable advantage to be taken of the motor vehicle's ability to give door-to-door service, and the railway's to move full loads economically at speed. By eliminating handling of individual articles at terminals, they enable the railway to compete with door-to-door service offered by the road haulier. Containers often reduce costs because less individual cases are needed, and there is no cost to the trader in the return of "empties". They enable traders' experts to pack the goods, and the fact that there is no further handling of goods until arrival at consignee's premises lessens risk of damage and pilferage (see Plate 21).

Containers vary from virtually an open box suitable for a variety of loads, to insulated containers for ice-cream and frozen foods. Carrying capacity does not normally exceed 5 tons, but a few will carry 10 tons. It is necessary to keep tare weight to a minimum, thus the use of light alloys in construction has advantages. Included in the range are covered containers for general merchandise, furniture, bicycles, meat and bulk materials (with roof loading and gravity discharge); also mobile 1-ton containers fitted with wheels for easy movement in firm's premises and over shed decks. There are open containers for bricks

and other manufactured articles. Cartage costs of containers tend to be high, as loads are often light and because of the detention of vehicles at customer's premises. On account of this, articulated vehicles have many advantages and, if possible, the haulage unit should have loads in both directions.

Lifting Apparatus. Mechanical appliances are required for the transfer of heavy consignments and of unit loads between road and rail vehicles. The main types are: mobile cranes; overhead travelling cranes; fork-lift trucks. There are some fixed cranes but they are rapidly being withdrawn as they are limited in use and create an obstruction to movement.

Mobile Cranes. The mobility of this type of crane is a considerable asset. They are often fitted with a jib which can be lowered to enable them to reach inside covered vehicles.

Overhead Travelling Cranes. Overhead cranes save ground space. They have a greater speed of movement than mobile cranes, and have the advantage that they can serve sidings which are not immediately alongside roadways.

Fork-lift Trucks. Apart from raising and lowering articles on the forks, fork-lift trucks can be fitted with a crane attachment which permits them to perform similar duties to a mobile crane.

Mobile equipment such as mobile cranes and fork-lift trucks tend to be less expensive initially, but their annual costs are likely to be higher than for an overhead crane, which has a longer life. Each type of lifting apparatus has its own merits and demerits in operation and selection must depend on local circumstances.

If the use of lifting apparatus can be avoided altogether there are obvious advantages. A cheap, reliable method which embodies the principle of a lateral transfer of the wagon body or container between road and rail vehicle is advantageous. In overseas countries the conveyance of the entire road trailer by rail (sometimes called the piggy-back system) is more common than in Great Britain where the severe gauge restrictions limit its scope. The use of a road/rail vehicle, as described in Chapter 3, may prove efficient in certain circumstances. The use of containers involves the employment of expensive equipment to transfer them from one medium to another at the terminal, but avoids the cost and the idle time of wheels, tyres, axles, brakes, springs, etc., which is unavoidable when road/rail trailers are used.

Received Warehouse Traffic. Wagons containing warehouse traffic are placed inside the warehouse or adjacent to it for unloading. This work is normally done by railway staff. Goods received to be stored in a warehouse do not have the same urgency as those required for im-

mediate use by the consignee, but it is still often a matter of some importance to unload at once to release the wagons for further use.

METHODS OF WORKING—WAGON LOAD TRAFFIC (COAL)

It is better for inwards coal traffic to be segregated from other traffic because of the dust nuisance and also to avoid conflictions in cartage movements. Unloading may be through the bottom door of the wagons into hoppers or pits below rail level. It may also be performed by a grabbing crane, wagon-tipping apparatus or manually. The railway do not normally undertake road transport of coal, but this may become necessary on a wider scale as concentration proceeds. (See *Concentration of Wagon Load Traffic*, page 128.)

METHODS OF WORKING—SUNDRIES (FORWARDED)

Sundries traffic may be loaded direct from the road vehicle to the wagon (perambulation) or may be transferred over a platform.

Perambulation (see Plate 27)

The empty wagons which are to be loaded and forwarded (stand wagons) are placed into sidings with road access, before the traffic to be forwarded begins to arrive at the terminal. They are identified according to their destination and are set up in the same formation each day so that the lorry drivers and loading staff know where to find each one. The formation is so arranged that the least amount of shunting requires to be done after loading is completed. There should be a regular forwarding to specified destinations which are known to have sufficient regular traffic to justify it. In addition the terminal staff should be authorized to load wagons to other destinations when there is enough traffic for them. This will reduce intermediate transhipping.

As each road vehicle arrives in the depot it is joined by a checker. For each consignment there is a consignment note which has been prepared by the sender. The driver's notes are passed to the checker who can see from them for which of the stand wagons there is traffic. The road vehicle perambulates alongside the stand wagons stopping as necessary. The traffic is checked against the consignment notes and is then transferred directly into the rail wagon. Efficient working is dependent on the motor drivers loading their vehicles intelligently at the traders' premises to facilitate off-loading during perambulation. Loads not suitable for direct loading on account of their miscellaneous nature may require a primary sort, and this may be done on to internal vehicles which can then perambulate around the stand wagons. Heavy items may be transferred by mobile crane or fork-lift truck.

As with so many other activities there is a tendency for peaks to arise. With forwarded sundries traffic the peak is in the late afternoon. The road vehicles which serve the outlying areas may not be able to arrive back any earlier because of the distances involved. Those vehicles serving the traders who are situated nearer to the terminal concentrate mainly on deliveries in the early part of the day.

Whether a sender is near to the terminal or some distance from it he is likely to prefer a collection fairly late in the afternoon to meet any urgent orders that arise and to clear his despatch department of most of the current day's work. The operator must seek to spread the peak. Too many road vehicles arriving in a short space of time are likely to be subject to delays in waiting for checkers and also on account of congestion. Only one lorry can be in position to transfer traffic to a particular rail vehicle at one time. To have other vehicles queueing up to get alongside that wagon is to waste the time of the drivers, checkers and vehicles. They are also likely to impede the free movement of other cartage vehicles. The delay to the traffic which results from congestion may have one of the following effects:

(1) Some traffic may not be transferred to the rail vehicle before train departure time and in consequence is left over to the following day.

(2) Trains may leave late owing to late loading of wagons.

It is worth while to secure the co-operation of some traders to obtain some of their traffic earlier in the day, even if this involves the cartage vehicles calling upon them more than once. If some goods for despatch can be collected in the morning at the same time as goods are delivered, the perambulation peak is reduced and cartage efficiency is increased by back-loading from the traders' premises to the terminal. This must not be carried too far or the vehicles concerned are likely to be late in making subsequent deliveries of inwards traffic.

At those stations dealing with transhipments the merchandise arriving by rail for re-forwarding by rail is loaded on internal perambulation vehicles and directly reloaded from these into the appropriate stand wagons. This work should be done before the afternoon peak with forwarded traffic commences. No checking is required with transhipments. There is benefit in having protection from the weather for perambulation work, as more efficient working is possible in a covered area. Adequate lighting is necessary as label and consignment details have to be read.

Loading via Platforms

Perambulation makes big demands on space, and if there is an inadequate amount available it is sometimes necessary for the forwarded sundries to be dealt with over the goods-shed platforms, which are also

used for the received sundries. The method of working is for the cartage vehicle to be placed against the platform. As the goods are off-loaded they are checked against the consignment note, and then transferred along the platform to the appropriate stand wagon. The stand wagons have been previously set up as described under *Perambulation.*

The movement over the platforms from road to rail vehicle can be done by various methods. The more common ones are:

(1) *Power trucks with fixed platforms.* The goods are transferred from the cartage vehicle to the power truck and loaded on the latter in an orderly manner to facilitate off-loading. The truck perambulates along the stand wagons, as the cartage vehicle does under full perambulation. The electric-truck driver is present when his truck is loaded and is familiar with the composition of each load.

(2) *Power elevating trucks and stillages.* When the traffic is taken from the cartage vehicle it is sorted on to stillages which have previously been designated for particular stand wagons. Elevating trucks transfer the stillages to the side of the appropriate wagons as necessary and, after they have been unloaded into the rail wagons, returns them to the cartage unloading point. In this case the truck and driver are not detained either at the cartage vehicle or at the wagon side.

(3) *Hand barrows.* At some stations the goods are transferred by hand barrows. Movement is slower and loads smaller than with methods 1 and 2, and labour costs per ton are likely to be higher.

Advantages of Perambulation over Via-Platform Loading

The main advantages of direct loading of forwarded sundries (perambulation) as compared with the method employing a platform are:

(1) Time is saved—because movement across the platform is eliminated.

(2) Fewer staff are required because truck or barrow operators are not required and cartage staff assist in loading.

(3) There is less risk of damage at the terminal because the traffic is handled only once.

(4) There is less chance of consignments being divided between more than one wagon (known as splitting of consignments).

(5) Mobile cranes can operate more freely when not impeded by platforms.

(6) It speeds up the handling of inwards sundries because the goods-shed platforms are freed of outwards traffic.

Disadvantages of Perambulation

(1) The main disadvantage is the longer detention of the cartage vehicle at the terminal, which increases cartage costs. At depots where

articulated vehicles in the form of motor units and trailers are employed, separate motor units may be employed for internal work including perambulation, which avoids detention of the vehicles and drivers.

(2) Perambulation may have an adverse effect on the turn-round of rail vehicles as well as that of road vehicles. It is necessary for the empty stand wagons to be in position before the first goods for forwarding arrive at the terminal. This may be quite early in the morning. Therefore, practically all the inwards loaded wagons discharged after this time cannot be loaded out with sundries traffic on that day. By the time these wagons could be transferred to another depot they might be too late for loading that day and consequently wagons are often held at the original depot and used for perambulation stand wagons the following day. This introduces an extra day on to the wagon turn-round time as compared with terminals where inwards and outwards sundries are dealt with over a common platform. In this case it is customary to concentrate on unloading inwards wagons until the early afternoon and then to use the wagons which have just been discharged, for outwards loading.

(3) The freight to be conveyed by a stand wagon arrives for loading in no particular order. The lighter goods which should be stowed on top of the load may arrive first and the heavier ones later. When loading takes place alongside a platform this may be used to hold goods which arrive early but need stowing on top, and generally to facilitate good stowing of rail wagons. This is more difficult to do when the perambulation method is used.

METHODS OF WORKING—SUNDRIES (RECEIVED)

With inwards sundries the normal method of working is over a platform. Direct loading from rail vehicle to road vehicle is not practicable because:

(*a*) the contents of the wagon are not known until it is unloaded.

(*b*) the traffic has to be sorted according to the location of the consignee's address. (The area served by the terminal is divided up into cartage rounds.)

(*c*) details of the traffic have to be entered on to the motor driver's delivery sheet as it is loaded on to the appropriate vehicle.

(*d*) in some cases, the cartage vehicle is loaded to facilitate its subsequent unloading when calling at the premises of the various consignees.

The inwards loaded wagons are placed against the platforms and as they are unloaded the goods are transferred to the appropriate cartage vehicles. These vehicles have previously been set up in a specified order at a section of the platform known as the cartage front. The cartage

front should have a sufficient number of berths to enable vehicles for each delivery round to be in position to receive traffic. The details of the consignment are taken from the labels and entered on the delivery sheet as the goods are placed on the cartage vehicle. Inwards transhipments require no documentation and are transferred to the appropriate rail wagon by internal perambulation or by truck over the platform.

The lay-out of the received shed, the volume and nature of the traffic, and the available working hours all have a bearing on the type of equipment employed. Some of the methods are briefly described in the following paragraphs.

Slat conveyors are continuously moving belts in the floor of the platform (see Plate 24) which transport goods from the unloading point to the cartage vehicle without human intervention. Incoming wagons are set alongside the conveyor, and unloading staff discharge the traffic from the wagons on to it. Packages are marked to assist easy identification of the delivery round and when they have travelled on the conveyor alongside the appropriate cartage vehicle (internal or delivery) they are transferred manually from the belt to the vehicle.

Where more than one conveyor is employed, they must converge into one before the town delivery vehicles are reached, as traffic for any delivery round may arrive on any belt. If this is not done it is necessary to transfer the traffic from each belt on to internal vehicles for subsequent transfer to the town delivery vehicles.

The merit of the conveyor belt is that it moves the goods without the employment of staff. The same work could be done by truck, but manpower costs would be considerable. The initial cost of a conveyor is high, but running costs are low. The conveyor has a long life and costs are lower than with mobile equipment. Important disadvantages are: (1) Considerable time of the men who take the traffic off the conveyor and transfer it to the vehicles is likely to be unproductive. Adequate staff is needed to clear the conveyor currently of traffic for each cartage vehicle, as the failure to do this means stopping the conveyor and halting wagon unloading. When there is no traffic for a particular vehicle (or vehicles) for a short time, the staff responsible for transferring from the belt may be kept waiting for work. When traffic is below normal levels, the staff who take it from the belt cannot be reduced in proportion to the decline in traffic, and costs will rise. (2) There is considerable fatigue putting packages down to floor level and lifting them again. (3) When the capacity of a conveyor is reached and it is not desirable to increase the capacity by increasing the speed of the conveyor, it is necessary to introduce another conveyor or conveyors. These may convey traffic for any cartage vehicle, and this raises the

problem of amalgamating the loads of each of the conveyors. (4) Cranes may be needed for heavy or awkward packages.

Power Elevating Trucks and Stillages. The traffic is transferred out of the wagon to stillages. The truck driver picks up the loaded stillages at the wagon side and, after examination, takes them over the platform to the appropriate cartage vehicles or to the forwarded section.

Power trucks with fixed platforms receive the traffic directly from the incoming wagons. The driver assists in loading the truck and is conversant with the composition of his load. He then drives it along the platform to the cartage front and perambulates to the appropriate delivery vehicle or with transhipping to the internal perambulation vehicle. The drawback with this type of truck is the detention of the vehicle and driver at both the wagon and the cartage vehicle. On the other hand, traffic is loaded more quickly on to a fixed platform truck as the platform can be situated alongside the wagon door, whereas with several stillages some are bound to be some distance from the door.

Electronically Controlled Trucks with Trailers. The trucks described in the two preceding paragraphs provide greater flexibility than the slat conveyor. On the other hand, they require staff to control them and must be either driver-controlled or pedestrian-controlled. A system which gives more flexibility than the conveyor and at the same time does not require staff to control the power trucks, is one which employs electronically controlled trucks (tugs) with trailers (see Plate 25).

The goods are transferred from the wagon into one of a number of trailers according to the delivery round or internal cartage vehicle required. When a number of trailers have been loaded they are hauled by tugs, each of which is fitted with an electronic programme unit. This controls the selection of routes and the truck and trailers stop automatically at the appropriate cartage fronts where the trailers for that particular cartage round are detached and any empty trailers on hand are attached. After all loaded trailers have been delivered, the tug automatically returns with the empties to its appointed discharge point. An electronic wire guidance system causes the tugs to follow a single wire laid $\frac{1}{2}$ in. below the surface of the goods shed, and these wires are laid as required, from the wagons being unloaded to the cartage fronts.

A further advantage over conveyors is that preliminary sorting into unit trailer loads assists the work at the cartage front. In addition, at that point there is a pool of work to keep staff continually employed, without detention of the tug. This method permits discharge of wagons to take place concurrently at more points than is normally practicable with slat conveyors.

Wagon unloading machines enable two men to be employed unloading

one wagon. The machines are power-driven conveyors the nose of which is inserted in the wagon. The two men inside the wagon stand on each side of the conveyor and place the goods thereon. The conveyor transfers the goods to the sorting staff who segregate them on to road vehicles according to their destinations. Cranes are required for dealing with heavy or awkward articles.

Hand barrows are used in places to perform the operations described above for power trucks. Movement is slower, loads are smaller and staff costs higher than they would be if the process were mechanized.

GENERAL PRINCIPLES IN TERMINAL OPERATION

It is possible to nominate four main principles in relation to terminal working to assist in the achievement of the aims which were defined at the outset.

(1) *Reduce handling operations to a minimum.* It has been explained that with full loads and with forwarded sundries, it is often possible to make a direct transfer between road and rail vehicles. This confines handling to one occasion in the terminal concerned. If full loads are in a container, a demountable wagon body, or a road/rail vehicle, the goods themselves are not handled at all, and the transfer operation takes only a short time.

Palletization is another method of avoiding the handling of the individual consignments. Just as the waiter reduces his movements between kitchen and table by using a tray, so in transport it is possible to reduce movements and handling by stacking the goods on a pallet. A pallet is a portable platform, with or without a superstructure, for the assembly of a quantity of goods to form a unit load. It may be handled by either a pallet truck or a fork-lift truck. The most advantageous palletization is that which extends throughout the whole transport process from the premises of the consignor to those of the consignee. If throughout palletization is not possible, the operator may still gain benefit from using pallets either within a terminal or better still throughout the time the goods are in his possession. Sundries traffic does not lend itself to palletization beyond the use of stillages within a terminal as previously described. This results from its varied nature and destinations.

Palletization has the following advantages in common with other methods of making unit loads, such as the use of containers: (1) accelerated transits due to faster movement through terminals; (2) reduction in damage due to less handling; (3) saving in labour; (4) less fatigue for the staff and less accidents in handling; (5) facilitates storage; (6) may permit lighter packing to be used. It must be debited with: (*a*) the cost of pallets and the lifting apparatus, plus maintenance costs; (*b*) the in-

crease in dead weight to be conveyed; (*c*) some transport of empty pallets.

With sundries conveyed over platforms instead of direct transfer between vehicles the minimum handling is from the incoming vehicle to barrow, truck or conveyor and then from the latter to the outgoing vehicle. This is a minimum of two handlings in each terminal, but unfortunately there is a tendency to increase this by "dumping" goods on the platform of the goods shed. If inwards sundries are not to be delivered but are to be called for by the consignee, dumping is unavoidable. Dumping also arises at the cartage front when there are insufficient berths to enable a cartage vehicle for each round to stand against the platform. It happens in two-way shed working, when goods for forwarding arrive at the wagon side before unloading of the wagon has been completed, or if there is insufficient wagon space in the shed to accommodate all stand wagons concurrently.

All goods put on to the platform have to be lifted up subsequently. Putting them down and lifting them is extra handling which increases working costs and makes the risk of damage or theft greater. Dumped goods impede free movement on the goods-shed platform, thereby slowing the whole of the work. Also there is a risk that dumped goods will be temporarily overlooked.

(2) *Make the best use of the vehicles.* The second principle of terminal operation relates to all vehicles whether they are railway wagons, road vehicles or the vehicles used to convey goods over the platforms in the goods shed, even including the humble hand barrow. It is a matter of maintaining movement and of obtaining maximum vehicle loading on each trip. With rail wagons, unloading should be performed currently and they should be reloaded and forwarded the same day if possible.

With road vehicles, only the minimum detention should be permitted both at the terminal and at the customer's premises. The advantage of the articulated units is apparent, as this often permits the driver and the motor unit to perform other work while loading or unloading takes place. Detention at the terminal is likely to be least when complete fluidity of movement is maintained. Congestion is the enemy of efficient operation. It can be avoided by proper design of the layout, by keeping the different stages of work up-to-date and by spreading peaks. If outwards traffic is not cleared from road vehicles in the evening, not only are the goods delayed but there is also a reaction on the inwards traffic next morning because the cartage vehicles left underload are not immediately available for reloading. The amount of detention at traders' premises is influenced by the method of working at the terminal. If the loading of sundries on a cartage vehicle is done to facilitate unloading, the length of each call may be reduced.

Making the best use of internal vehicles such as power trucks and hand barrows depends on the same principles. Minimum detention at the wagon side and at the cartage front are important—this is why stillages are often advantageous. To maintain fluidity of movement on the goods shed the following points should be borne in mind:

(*a*) Dumping of traffic should be avoided.

(*b*) One mobile crane will do the work of many fixed cranes and cause no permanent obstruction.

(*c*) The minimum number of trucks should be employed commensurate with the work to be done, and they should make the minimum number of trips.

(*d*) At the cartage front, cartage vehicles should be arranged in a specific order to minimize trucking distances.

In item (*c*) emphasis was laid upon the employment of the least number of trucks. The number employed relates to: (1) the amount of traffic; (2) the distance it requires to be trucked; (3) the load per trip; (4) the number of trips each truck makes. Distances should be as short as possible and this matter should be carefully considered when sheds are being designed. Platforms should not be unnecessarily long or wide. Apart from extending trucking distances unnecessarily large platforms are an invitation to dump goods. In Chapter 1 it was mentioned that unnecessarily large operating units lead to inefficient working and here is a further example of it. Good loading is particularly important as by the nature of the work there is, more often than not, one empty return trip to be made after each loaded one. Truck design and careful loading are important features in increasing truck loads.

(3) *Maintain continuity of work.* The interdependence between the cartage vehicles, the rail vehicles and the trucks, where employed, has been mentioned under the previous heading. The basic requirement is a sufficient number of each type of vehicle (but not too many as this causes congestion) to deal with the traffic. Having done this it is necessary to keep them continuously employed, as a hold-up on any section of the work is likely to react on other sections. Similarly, the disposition of staff must be evenly balanced between those who are unloading wagons and those loading cartage vehicles, or vice versa, so that a steady flow of work is maintained. To maintain continuity of work it is necessary to: (*a*) ensure the staff have a continuous supply of work; (*b*) keep the staff at work. Adequate supervision and good discipline are important. Many terminals have incentive schemes in operation.

One of the main considerations under (*a*) is to keep up a continuous supply of inwards loaded wagons to the discharging staff. If after a wagon or a batch of wagons have been unloaded there is a lapse of time

while the empty wagon (or empties) is removed and replaced by a further loaded wagon or wagons, unloading is held up and the reaction may extend to the cartage front. This is an important point to bear in mind in the designing of terminal lay-outs and in selecting the equipment to be employed to move railway wagons within the terminal.

The main wagon moving devices are: (i) winches or capstans; (ii) traversers, for transferring wagons between parallel sidings; these are more economical in space than points and crossings; (iii) tractors; (iv) shunting locomotives; (v) pinch bars, which are simple portable devices for the manual movement by leverage of wagons over short distances.

The fixed equipment, such as capstans and traversers, has some advantages over the mobile equipment, tractors, shunting locomotives etc., as they are available for use when required, whereas the mobile equipment has to visit various parts of the depot so that it may be kept more continuously employed. If it is in the wrong place when required, hold-ups occur. The tractor cannot move such large rafts of wagons as a shunting engine, but is cheaper and more flexible.

(4) *Mechanize handling*. To reduce handling and to make the best use of vehicles it is clear that mechanization in some form is often the answer. There is a wide range of mechanical aids, and new appliances are being developed. For horizontal movement, conveyors, trucks, stillages, pallets, and internal road vehicles have been mentioned. For vertical movement, in addition to cranes and fork-lift trucks previously discussed, there are hoists, elevators, lifts and chutes. Choice of equipment can be made only after a study of the work to be done. Selection should then be made bearing in mind the fundamental reasons for mechanization: (*a*) to reduce costs; (*b*) to increase efficiency; (*c*) to provide better service; (*d*) to increase safety.

The reliability and the maintenance needs of the mechanical equipment must be borne in mind. The degree of mechanization which is feasible from the economic point of view depends on the amount of traffic passing through the terminal. It is necessary now to consider the desirability of concentrating traffic at fewer terminals to increase the traffic passing through the individual depot, which should facilitate mechanization.

CONCENTRATION

There has been a reduction in the number of freight terminals and further reductions are taking place. This need not affect the country-wide service which is provided. It does involve road services operating over wider areas from the terminals that remain. These longer distances covered by the cartage vehicles increase cartage costs. It is desirable to

consider the advantages to be gained by concentrating freight traffic at fewer terminals in order to absorb the increased expense on cartage. Sundries and wagon load traffic will be dealt with under separate headings.

Concentration of Sundries Traffic (Zonal Collection and Delivery Schemes)

Prior to the development of the internal-combustion engine for road motor purposes it was necessary for a large number of terminals to be located throughout the country, to reduce the distance between the customers' premises and the terminal. Transfer between these points was horse-drawn and quite short journeys took considerable time.

The many small stations at which sundries originated could only dispose of them by loading to the nearest large terminal for transhipment. Similarly, sundries consigned to these small stations from other places had also to be sent to the same depot for sorting and despatch. All this meant a great deal of transhipping, the disadvantages of which are: (*a*) it extends the transit of the consignments; (*b*) it increases the number of handlings and thereby risk of damage; (*c*) it increases working costs.

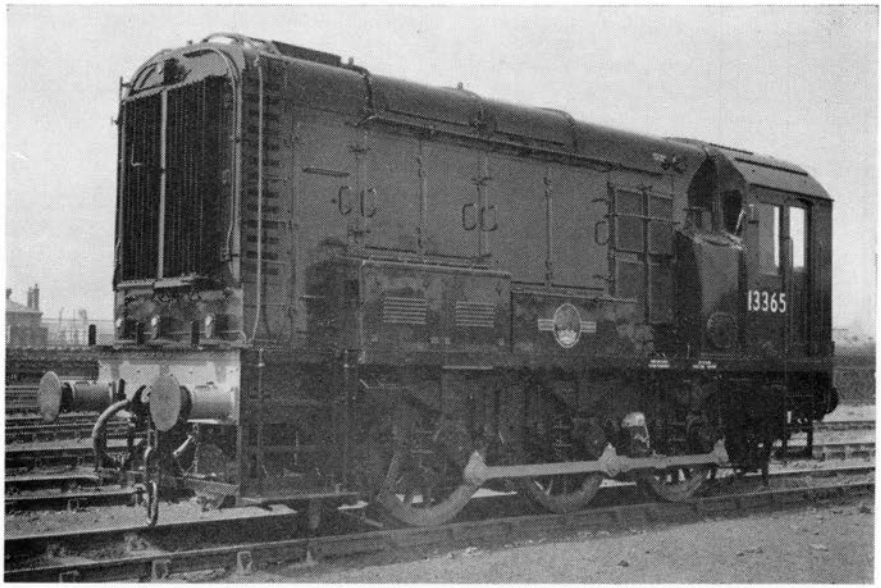
During the post-war years the railways have gradually developed a scheme known as the Zonal Collection and Delivery arrangements for withdrawing sundries traffic from the small stations and concentrating it upon selected depots from which direct collection and delivery to or from the customers' premises is afforded. Thus, the traffic by-passes the small stations and the effect on the larger stations is to extend their cartage area. At the same time, the number of depots dealing with sundries has been drastically reduced.

A further extension of this policy envisages even fewer depots dealing with sundries and each serving a still wider cartage area. It is recognized that cartage costs will inevitably increase, but this will be offset by the many advantages to be gained. These are: (*a*) better transits by the use of fast fitted trains giving overnight transit between any two of the depots; (*b*) better loading of wagons by concentrating traffic at fewer points; (*c*) through train working reduces entries into marshalling yards; (*d*) fewer handling staff are required; they are employed at fewer centres, where the concentration of traffic justifies a greater degree of mechanization.

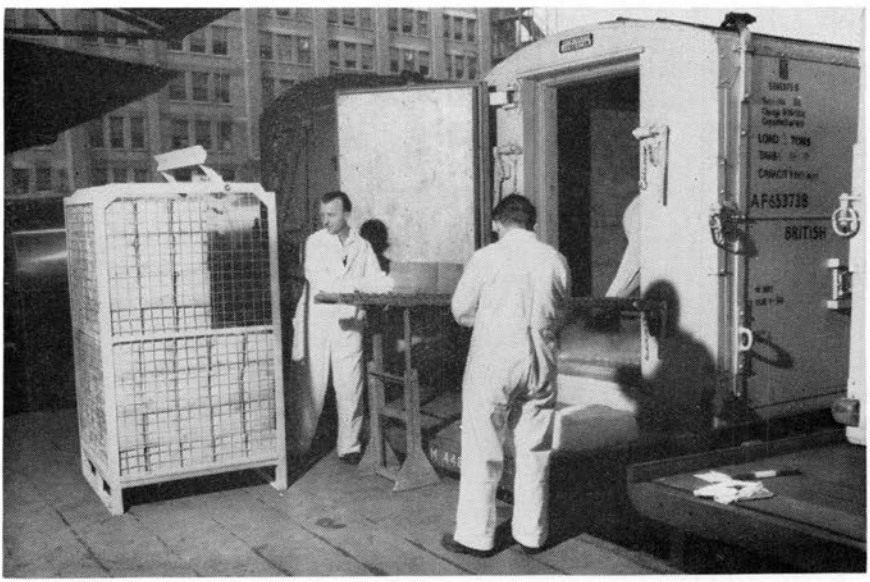
Concentration of Wagon Load Traffic

When the zonal collection and delivery system was well established the full wagon loads were still left to be dealt with at many small stations and sidings throughout the country. Although the problem of transhipment does not arise there are a number of operating difficulties in the dispersal of traffic among a large number of places, including:

(1) Transits to and from small stations are often unavoidably bad.



(*Above*) PLATE 20. *For shunting work mainly diesel shunting locomotives are used. This is a* 350-*h.p. diesel-electric type.* (*Below*) PLATE 21. *Traffic is being transferred from one type of unit load* (*a stillage*) *to another* (*an insulated container*) *at a trader's premises, using a gravity roller.*



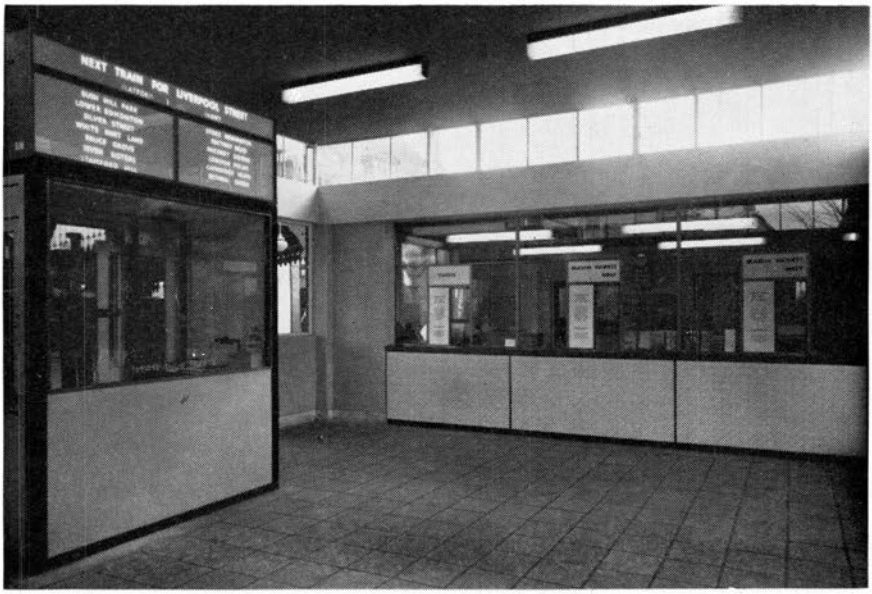


PLATE 22. (*Above*) *The booking hall at Enfield Town* (*Eastern Region*) *station; the separate windows for the booking of season tickets are an important feature at suburban stations. The ticket collector's cabin gives him good protection from draughts without impeding his vision.* (*Below*) *Booking office at Southend-on-Sea Central* (*Eastern Region*) *station, showing the Multi-printer ticket printing machine.*

PLATE 23. (*Above*) *Control tower at Temple Mills* (*Eastern Region*), *showing two of the secondary retarders.* (*Below*) *One of the fully automatic retarders at Margam* (*Western Region*) *marshalling yard.*

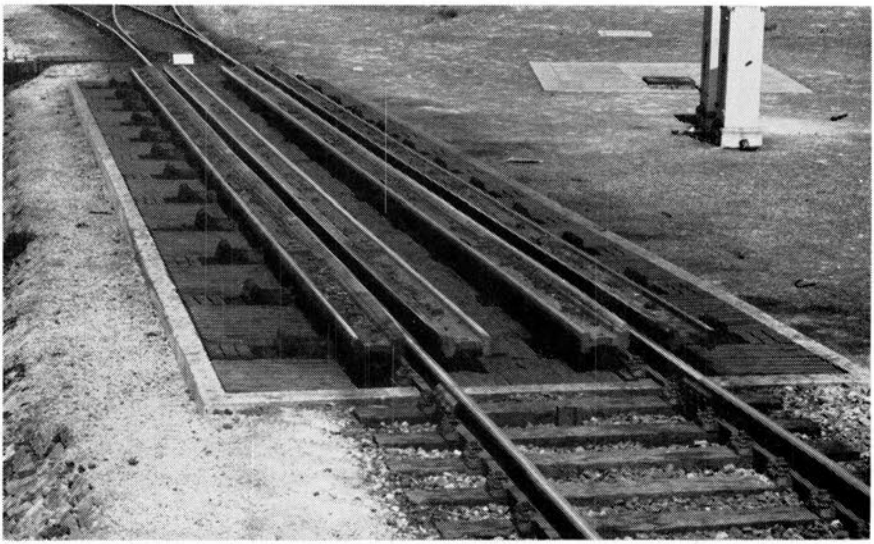


PLATE 24. *Grimsby (Eastern Region) Central Market goods depot, showing the slat conveyor and the cartage front.*

PLATE 25. *Electronically controlled tug at Wolverhampton (London Midland Region) leaving the wagon side. From this point it follows whichever route has been selected on the programme unit, stopping automatically at the appropriate cartage fronts, where the trailers for that particular round are detached.*

If a station deals with only two or three wagons a day, one cannot economically provide a service more than once a day. This is not conducive to good transits. In addition, if traffic originates from and terminates at many stations, more entries into marshalling yards are required than is the case when working between fewer larger stations which are more likely to be able to despatch traffic in full train loads through to destination. Entry into marshalling yards prolongs transits and, therefore, increases the cost for the provision of wagons.

(2) Costs of conveying traffic to and from small stations is high because of:

(*a*) The necessity to enter marshalling yards.

(*b*) Detailed marshalling of wagons is required in marshalling yards to facilitate pick-up trains detaching at wayside stations.

(*c*) Provision of pick-up and feeder trains is expensive because of small loads. This problem has been accentuated by the withdrawal of wagons of sundries from these trains, which left the full wagon loads to bear higher movement costs than previously.

(*d*) Provision of pick-up trains is expensive because of slow speeds. Because of the nature of the traffic, the types of motive power used, and because of frequent stops, they remain the slowest type of train.

(*e*) If the stations happen to be on branch lines on which the passenger services are few or where they have already been withdrawn, a formidable cost for the provision, maintenance and operation of track, signals, stations, level crossings etc., as well as movement costs, have to be borne by this traffic.

(3) Terminal costs may be high because: (*a*) overheads have to be borne by too few wagons; (*b*) difficulty may arise in keeping staff and equipment continuously employed; (*c*) small amounts of traffic do not justify mechanization. The rewards for closing down the smaller terminals and concentrating the handling of full wagon loads at fewer points are, therefore, worth striving for. Improved service and reduced costs of operation, which may include the closing of marshalling yards and branch lines, are perhaps the only way in which the railways may be able to compete for certain traffics.

There are many difficulties to be overcome and progress on concentration of full loads has been slow. Among the drawbacks are:

(1) The economies set out above may not be achieved unless traffic to and from private sidings and rail-connected tenancies, served by the same pick-up trains as the terminals to be closed, is also transferred to the concentration point. In dealing with this traffic through terminals instead of private sidings, extra handling and cartage costs are being introduced, and the trader is not getting the same type of ser-

vice that he enjoyed before, *e.g.*, he may be required to unload a lorry immediately it arrives rather than being permitted to unload a wagon at his convenience.

(2) Some traders who prefer to do their own cartage may not be prepared to travel greater distances to concentration points.

(3) Cartage costs are likely to increase substantially, but it should not be assumed that an increase in the number of cartage vehicles *pro rata* with increased vehicle mileage is necessary. The capacity of an operating unit depends on how it is used, and increased productivity of existing cartage vehicles may be obtained. In certain cases vehicles may be employed for two drivers' shifts instead of one. Another possible effect of the concentration of full loads is that the railway may be required to collect or deliver traffics not previously carted—coal, for example.

Each case presents different problems. There is a great difference between the station on a branch line served by one pick-up train a day—where all track and signalling costs could be saved after concentration —and another station where the only savings would be train-operating costs. Similarly, the considerations are quite different on a line where line occupation is high and one where it is low. In the former case the withdrawal of a pick-up train could make a very great difference to efficiency in operation.

Concentration of full-loads might result in some loss of traffic, which would be diverted to the road. This does not necessarily mean that concentration in these circumstances is wrong. In all cases one must relate the revenue received for providing the service against the cost of performing it. Concentration of full-loads is certainly worth investigating in view of what has already been mentioned about freight rolling stock utilization and costs, and in relation to freight-train services and freight-traffic transits; these are discussed in subsequent chapters.

SUMMARY

1. *The traders' need is door-to-door transport.*
2. *The railway must devise quick, cheap and safe transfer between road and rail vehicles.*
3. *Reduce handling by direct loading and by the use of unit loads where possible.*
4. *Avoid dumping.*
5. *Save manpower and speed movement by mechanization.*
6. *Intermediate transhipment should be avoided.*
7. *Minimize detention of vehicles, both road and rail.*
8. *Freight traffic should be concentrated at railheads to exploit the natural advantage of railways as bulk carriers.*

CHAPTER 8

Marshalling Yards

MARSHALLING yards are expensive to construct, to maintain and to operate. Their use involves interruption to the movement of all wagons that enter them and introduces additional damage risks. This being so, it is necessary to consider first why these costly units with their inherent disadvantages are needed.

In Chapter 1 it was explained that the superiority of rail transport lay in its ability to convey large loads, of as much as 1,000 tons of traffic, at speed with a single motive-power unit and crew. Unfortunately there are few industries whose unit of trade is anything like 1,000 tons. Power stations and similar installations may accept coal in train loads, and steel works may accept ore in similar quantities, but most of industry requires its freight in smaller lots. When considering freight terminals it was seen that many consignments are even less than a wagon load and that it is part of the terminal function to combine these small consignments (sundries) into wagon loads. The marshalling yard has to continue this process and assemble wagon loads into train loads. Just as the sundries had to be sorted before being combined, so the wagons must be sorted before they can be assembled into train loads.

If trains leaving marshalling yards are required to detach wagons at stations or yards *en route*, the detention of the trains at those stations will be less if the wagons to be detached are grouped together, and conveyed on the train in suitable formation. In these circumstances a further sorting of the wagons (secondary sorting) is often done before departure from the marshalling yard. Another type of secondary sorting may be called for before the departure of trains conveying some wagons fitted with vacuum brakes and some without. In this case it is necessary to segregate sufficient fitted wagons to make up the fitted section and place these next to the locomotive. Therefore, the purpose of marshalling yards can be summarized thus: (1) the sorting of wagons according to their destination; (2) combining them into train loads; (3) forming trains to facilitate detaching *en route*, if required.

FORMATION OF MARSHALLING YARDS

Sorting Sidings. If wagons are to be sorted, the basic need is sidings in which they can be shunted; these are normally known as marshalling

or sorting sidings. If sidings are permanently allotted to wagons for certain trains or destinations they are said to have a fixed allocation. Fixed allocations may still permit a particular siding to be used for certain destinations for part of the day and for other destinations for the remainder. Fixed allocations simplify shunting and help to reduce wrong sorts to a minimum. Sorting sidings should be slightly longer than the length of the longest departing trains which will use them. If they are only the precise length of the trains, the last few wagons to enter must do so very slowly to avoid heavy impacts, and this slows down the speed of shunting. The longer sidings are normally allocated to the destinations served by long trains. When train loads have been completed it is imperative that they are cleared immediately so that the siding becomes available for further use and to avoid unnecessary delay.

The number of sorting sidings required depends on the number of sorts it is required to make. A common problem in marshalling yards is an inadequate number of sorting sidings, which necessitate using one siding for more than one sort, and shunting the wagons again later to effect the full separations. Alternatively, a yard with too few sorting sidings, although it receives sufficient wagons for certain destinations may, instead of forwarding through train loads to these points, combine them and send them to another marshalling yard *en route* for final sorting. As this action involves the wagons passing through an additional marshalling yard it extends their transits, increases damage risk and increases the costs of dealing with them.

The insufficiency of sorting sidings has been mentioned previously in connection with the distribution of empty wagons. The limiting factor on the number of sorting sidings is partly the curvature which arises on the outside sidings as they bend out from the shunting neck or hump. Curves of small radii would make the sidings unsafe for certain vehicles and are unacceptable. As the number of sidings increases, the distance from the hump to the clearance points of the farther sidings becomes greater. This also restricts the number of sorting sidings which may be made available. If the distance becomes too great, shunting speed is retarded. At the departure end, there is some reunion of the sidings as they connect into the outlet line or to the departure sidings.

A Shunting Neck or Hump. Trains arriving in the yard may bring wagons for any destination. A destination may be served by only one sorting siding. Therefore, in the sorting process each wagon must pass over a common piece of track which connects with all sorting sidings. This is called a shunting neck, but if it is elevated to permit shunting to be accelerated by gravitation it is called a hump (see *Hump Yards*).

Reception (or arrival) sidings are a useful facility as they permit in-

coming trains to stand clear of the running lines while awaiting shunting, before which certain preliminaries must be performed; they will be described later. These operations may be carried out while the train is on the reception roads and not occupying the running tracks. Trains may arrive faster than the yard is able to shunt them, but if an adequate number of reception sidings are provided there need be no delay in accepting trains into the yard, thus keeping the running lines free. The arrangement of reception sidings alongside each other permits the train engines to be released immediately after arrival. It also permits trains to be shunted in the order which suits traffic requirements best; this is not necessarily the order of arrival. Sidings should be long enough to accommodate the longest trains expected to arrive.

Secondary Sorting Sidings. Secondary sorting can be performed in the main sorting sidings, but at yards where there is a great deal of sorting, the provision of secondary sidings may be justified. This will permit secondary sorting to proceed without disturbance to the departure of trains from, or shunting within, the main sorting sidings.

Departure sidings may be justified for holding wagons which have been sorted into train loads but which are unable to depart immediately. This detention may be due to line-occupation problems, because of waiting for a locomotive or for other causes. They also permit coupling of vacuum pipes etc., to be carried out clear of the sorting sidings. While coupling is being done in a sorting siding it is necessary to suspend shunting into it. If departure sidings are provided in excess of operating needs they are an unnecessary expense and encourage inefficiency. From the time a wagon arrives on the reception siding to the time it is formed into a complete train on the sorting sidings, some interruption to its movement has occurred. It is desirable not to permit any delay beyond this. Full sorting sidings have got to be cleared otherwise shunting will be slowed down. In the absence of departure sidings, this is a fine incentive to get wagons on their way to their destination, but this urgency may be lost if there are departure sidings surplus to requirements. Where there are departure sidings constant attention is needed to ensure that trains are not left on them unnecessarily.

Effective lighting is important as most marshalling is done at night. It is advantageous to use powerful floodlights to reduce the number of supports required and to place those that are necessary outside the groups of sidings.

TYPES OF MARSHALLING YARDS

Flat, Single-ended. In this type of yard the sorting sidings have buffer stops at one end. Wagons are propelled from the shunting neck into the

appropriate sorting siding according to the destination of the leading wagon(s). After this or these have been detached, the locomotive is put into reverse and draws the remainder of the wagons back along the shunting neck. The points are switched to the sorting siding designated to receive the next wagon(s) and the locomotive changes direction again and propels the wagons into this sorting siding. This process continues until all the wagons have been placed in the appointed sorting sidings. The main disadvantage of flat yards is the frequent reversals of movement demanded of the locomotive; this limits the number of wagons that may be shunted in a given time. Other disadvantages of the single-ended yard are:

(*a*) The interruption to shunting involved by the departure of a train from the sorting sidings, as departing trains must cross the shunting neck.

(*b*) Late train departures from the sorting sidings arising from conflictions with shunting operations.

(*c*) If more than a train load of wagons is assembled in a sorting siding, some are left behind next to the buffer stops. Unless supervision is effective, further train loads may be assembled on top of those left behind, and despatched before them.

Reception sidings alongside the sorting sidings, are said to be *in parallel.* When reception and sorting sidings are on opposite sides of the shunting neck they are termed *in tandem.*

Flat, Double-ended. This type of yard has the same disability as the single-ended yard—a low shunting rate per hour because of shunting-locomotive reversals. But as the sorting sidings are double-ended, trains may depart from the opposite end to the shunting neck without interfering with the shunting taking place there. The problems of wagons being by-passed by later arrivals in the same sorting siding does not arise in this type of yard. The normal method of working provides for wagons to leave the sorting sidings in the same order they were placed in.

Hump Yards. As previously described, shunting-locomotive reversals diminish the speed of shunting. This method is inadequate for the work which requires to be done at many places. Increasing the number of shunting locomotives employed is unlikely to help. Because of the heavy use of the shunting neck, more locomotives tend to obstruct each other and to slow the rate of work. It is also an unsatisfactory answer to have multiple flat yards on the same site to deal with this problem as this would result in duplication of trains for particular destinations or the transfer of wagons between the various yards.

The hump yard eliminates reversals between shunts and can deal with three or four times as many wagons a day as the best flat yard. In the

hump yard the reception sidings are in tandem with the sorting sidings. They may be constructed on a gently rising gradient or on a fairly level gradient which rises as the shunting neck is approached. When the locomotive is detached the vehicles ease back on to the brake van thus facilitating the uncoupling process. Uncoupling takes place between wagons for different sorting sidings. If there are successive wagons for the same sorting siding it is not necessary to uncouple each vehicle. A *cut* is the name applied to a wagon or group of wagons for a particular siding.

The apex of the hump is on the shunting neck between the reception sidings and the sorting sidings. The shunting locomotive is placed behind the trains on the reception sidings and propels them up to the hump. This is a continuous process and no reversing is needed throughout the shunting of a whole train, which can be completed in a few minutes.

From the apex there is a steeply falling initial gradient towards the sorting sidings to ensure rapid separation of the cuts as they leave the remainder of the train under the influence of gravitational force and run down the hump into the appropriate siding. Rapid separation together with equal distances between the apex of the hump and the clearance points of the respective sidings is the secret of a good shunting rate, as points have to be reset after the passage of each cut, according to the destination of the next one. Resetting cannot be done until the previous cut has gone beyond the clearance point. Although each cut is affected by the same gradient and the speed of propulsion is kept constant, the speeds vary according to the weight and ease of running of the wagons and the number of them in a cut. Therefore, further action may be required to maintain the distance between the cuts, and this is discussed later under *Retarding*.

The gradient of the sorting sidings should continue to fall for a distance which will permit the first wagon into a siding to roll through to the departure end. Steeper gradients should be provided on the outer sidings in order to compensate for the curve resistance of the track on the wagon wheels. The straight roads in the centre of the yard are often most suitable for receiving empty wagons as these do not roll so well as loaded ones. Although it is necessary for the first wagon to go to the far end of the siding by gravitational force, it must not go beyond, and the sorting sidings should flatten out along their length and then rise slightly towards the departure end. Thus, in longitudinal profile the sorting sidings should be hollowed, rather like a saucer, so that the progress of the wagon is gradually retarded as it approaches the outlet end.

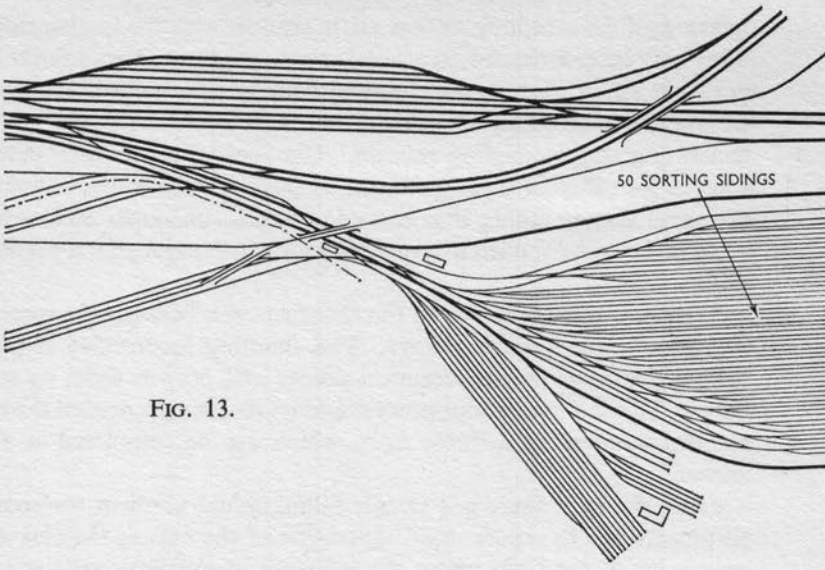
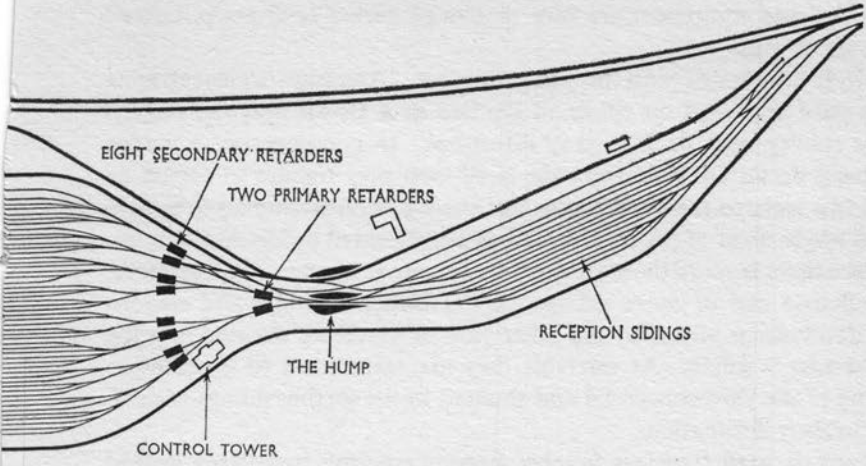


FIG. 13.

Efficient railway operation demands the employment of few marshalling yards. Therefore, the concentration of the work calls for yards capable of dealing with large numbers of wagons, and although the hump yards are not the most numerous group, they account for a large amount of the marshalling that is done.

Gravitational Yards. In some gravitational yards of which there are comparatively few, the falling gradient includes the whole of the reception sidings. Before the locomotive is released on the reception sidings, brakes are applied on sufficient of the leading wagons to prevent the train from running forward until the preliminaries have been completed. The wagons to the rear ease on to the braked wagons thus facilitating uncoupling between cuts. When the shunting of the train may commence, the brakes on the leading wagons are released and the train begins to run forward under gravitation. Along the shunting neck the rate of fall of the gradient needs to be increased in order to obtain sufficient separation between cuts for points to be reset. Gradients in the sorting sidings are desirable to perform the same functions as with hump yards; *i.e.*, initially falling to project wagons down the siding as required, and rising to assist retarding.

The advantage of purely gravitational yards is that they may be operated without the employment of any shunting locomotives. However, they are normally constructed on natural sites where the contour of the land reduces the amount of earthworks required, as the constructional costs would otherwise be prohibitive.



MARGAM MARSHALLING YARD

DESIGN OF MARSHALLING YARDS

Some yards are designed to deal with traffic flowing in one direction only. Those required to sort traffic flowing in both directions may have separate yards for Up and Down traffic. These will normally be referred to as the Up yard and the Down yard. Others, which also handle traffic flowing in both directions deal with all of it in one yard. (See the illustration of Margam Marshalling Yard, Fig. 13.) This arrangement has a number of advantages over separate Up and Down yards:

(1) Less land is required.

(2) It avoids duplication of fixed and mobile equipment. Only one control tower is needed instead of two. Fewer retarders, shunting locomotives, and staff are required and they are kept more continuously employed.

(3) It reduces peak costs. At a yard near industrial centres the peak for outwards traffic from these centres is likely to be in the evening when the feeder services arrive and are sorted to form the trunk services. With inwards traffic the peak is likely to be in the early hours of the morning, as the trunk services arrive and their wagons are marshalled to form the feeder services. If the inwards and outwards traffic flows are dealt with in separate yards, each must be capable of dealing with its own peak period. When the inwards yard is working to capacity, the staff and equipment in the outwards yard is under-employed and vice versa. With a common yard for the two flows,

the staff and equipment are fully employed during both peaks instead of only in one.

(4) It eliminates yard to yard transfers. Although trains arriving in a yard approach on either an Up line or a Down line, the wagons they convey may be for many directions. In consequence, a wagon arriving on an Up train from the north-east may require to depart on a Down train to the north-west. But the Up train is shunted in the Up yard where most of the sorting sidings are allocated to Up destinations. Where there is more than one yard in a group it is necessary, therefore, to allocate one or more sidings for " Transfer " traffic, and wagons for destinations served by the other yard or yards are shunted into the " Transfer " siding. At intervals they are transferred to a reception siding of the yard concerned and shunted to the sorting sidings according to their destination.

Yard to yard transfers involve wagons entering two yards instead of one and the interruption to their transit is prolonged in consequence. The risk of damage is increased and the cost of moving them from one yard to another has to be taken into account. At some places it is necessary to employ locomotives and train crews for extended periods on transfer work.

The restricting factor in the use of a common yard for Up and Down traffic arises from the limit on the number of sorting sidings which may radiate from one hump. To make the best use of the number of sidings available, the allocation of a particular siding may be varied at certain times in the day to permit one siding to serve more than one group of destinations. Different allocations can only be made with those sidings which are completely cleared after traffic for one direction has passed. For example, the sidings served by trains which run once daily and whose traffic arrives throughout the day are fully committed during the whole 24 hours. Similarly, traffic for destinations near to a marshalling yard may arrive from sending points near and far and, in consequence, arrivals may be at all hours. These destinations also require a siding allocated at all times.

METHOD OF WORK IN A MARSHALLING YARD

Because of the important role played by hump yards, the method of working in this type of yard will be discussed. Many of the considerations apply equally in flat and gravitational yards.

Reception Process.

(1) *Release of train engines.* As soon as trains arrive it is important that train engines and crews are released for their next job or despatched to the motive power depot if their work is completed.

(2) *The vacuum brake is released* on those wagons which have arrived with it in operation.

(3) *Wagon examination* is desirable on the reception sidings immediately after arrival in order that:

(*a*) Repairs of defects may commence at the earliest opportunity.

(*b*) Transhipment of traffic from disabled wagons may be arranged with the least delay.

(*c*) Disabled wagons are not shunted into the same sidings as sound wagons. If repairs or transhipment are required, they may be done more conveniently in sidings specially allocated for this purpose. Shunting out a wagon from a sorting siding because it is not fit to travel may cause delay to train departures from the yard.

(4) *Dividing the train into cuts.* The division of the train into cuts is performed concurrently with the wagon examination. The speed of cutting up is affected by the legibility of the wagon labels at a distance. The use of code numbers, letters or colours which can be identified at a glance may assist. Sending points should be most careful that wagons are properly labelled and that labels are affixed securely.

When the cuts are made, the shunter making them must inform the staff responsible for setting the points into the sorting sidings, of the respective siding for which each cut is destined. He may do this by various means, including:

(*a*) The compilation of cut cards. On the card is listed the number of the sorting siding to which each cut requires to go. Quick transfer of the card to the point operator is important; pneumatic tubes are employed for this purpose in some yards.

(*b*) Chalking on the wagons the number of the sorting siding required. The chalking must be easy to read from a distance and be on a suitable place on the wagon to be seen by the point operator.

(*c*) Transmitting details of the cuts to the point operator by short-wave radio. The person cutting up carries a small transmitter with him as he proceeds along each train.

In some yards two men are employed, one to uncouple the wagons, the other to advise details to the point-setting staff.

The selection of the order in which the various trains standing on the reception sidings should be shunted depends on the destinations of the wagons each conveys. Therefore, it is better that the train details should be known at a central point before the selection is made. This favours methods (*a*) and (*c*), as with chalking the destinations are not revealed until shunting of the train has commenced.

Shunting Process.

(1) *Propulsion to the hump.* Shunting engines propel the trains at a

steady speed to the hump, where gravity causes separation between successive cuts to be established. The points have already been set for the first cut and after this has cleared the points, they are reset for successive cuts. After a train has been shunted, the shunting locomotive must run back via a specially allocated line to the arrival end of the reception sidings and be directed to the rear of the next train which it is required to propel to the hump. This process wastes shunting time and it may be desirable to employ two locomotives, particularly at busy times, so that one may be propelling while the other is running round. The aim should be to pass wagons through the yard as quickly as possible, and uninterrupted shunting is one method of securing this. Some stoppages may occur when incoming train engines are being released from the reception sidings; the reduction of stoppages is an important consideration in yard design.

(2) *Point setting.* The first set of points beyond the hump divide the two halves of the sorting sidings and are known as the *king points.* The next points reached are known as the *queen points.* As there are two tracks beyond the king points there are two sets of queen points each of which set up two tracks, therefore there are four *jack* points, which are next in succession. The number of sets of points after this stage varies according to the number of sorting sidings employed.

Point setting at the hump end of the yard is often done from the control tower, which is an elevated building from which a view of the whole yard is possible (see Plate 23). It may be performed by levers, but modern equipment provides for centralized operation of power-worked points with track circuiting throughout the point area. This prevents points being moved while a wagon is travelling over them. By the use of throughout route setting, only one destination switch is used to select the route required. The operation of the points involved is controlled by the state of occupation of the track circuits. Some installations permit the routes for all cuts on a train to be set up before shunting begins, the information being stored on relays. The passage of a cut automatically sets up the points for the next cut.

Another method employed at certain yards is for the information concerning the siding destination and the number of wagons in each cut to be set up on a re-perforating teleprinter. This causes a perforated paper tape to be produced in code. When a train is about to be humped the appropriate perforated tape is selected and fed into a *tape reader.* The tape reader translates this information into electrical signals which cause the points to be set into the appropriate siding. The setting of points for successive routes is automatic and takes place when the previous cuts have cleared the appropriate track circuits.

By using a tape the information regarding the point setting is stored without the use of relays. In yards which are not so well equipped, points may have to be operated by individual hand levers situated on the ground near each set of points. This is likely to require several pointsmen, whereas with operation from a control tower one man can set all the points.

(3) *Retarding*. Once the wagons have been set in motion, braking is necessary to achieve two objectives:

(*a*) To maintain an interval between successive cuts to permit the resetting of points. If a cut is running faster than the preceding one and is permitted to catch it up, it enters the wrong sorting siding (a wrong shunt). This retarding can be called *interval braking* as it is designed to maintain the intervals established by the gradients.

(*b*) To bring the wagons to a stand at the correct place in the sorting siding without damage to either the wagon or its contents. This can be referred to as *distance braking*. The correct place for the first wagon to come to rest, when inside the sorting siding, is near the outlet end but clear of adjacent sidings. Successive wagons should come to rest immediately behind the previous wagon in the siding. If they come to rest short of the previous wagons, the gaps created prevent the siding being used to its full capacity. When this happens it is often necessary to interrupt shunting so that the shunting locomotives may be employed " pushing down " the sorting sidings concerned. This is a frequent cause of interruption to shunting and should be avoided whenever possible. If it cannot be avoided, " pushing down " should be performed at off-peak times or when other opportunities offer, without interference to hump shunting.

The opposite evil to wagons stopping short, is impacting against the wagons in the sorting siding too heavily. Impacts of 4 m.p.h. fully compress the spindle/spring buffer and the rest of the shock is taken by the wagon and its contents. This type of buffer is not really satisfactory but as long as wagons are fitted with it, the speed of impacts must be kept below 4 m.p.h. With hydraulic buffers somewhat higher impacts may be permissible without causing damage.

To perform both interval and distance braking various methods may be employed:

(*a*) Shunters, sometimes called brakesmen, runners or chasers, may be employed. They apply the hand brakes as necessary on moving cuts. This is expensive in manpower and the job is an energetic one suitable only for fit young men. There are risks involved as much running among moving vehicles over a surface having many obstructions is necessary. It is unpleasant and dangerous during bad weather. When this method

is employed, ideally, the chaser should accompany each cut until it comes to rest. The number of staff employed does not normally permit this to be done and shunters use their discretion regarding the amount of brake pressure to be applied and permit the cut to travel unaccompanied for the last portion of its journey, thus freeing themselves to attend to successive cuts. Although the experienced man acquires considerable judgment and skill, a number of heavy impacts and cases of cuts stopping short occur. In some yards a skid or slipper is inserted in advance of the leading wheel of the first wagon in the cut and the wheel is retarded by rotating against the stop of the skid.

(*b*) *Rail brakes or retarders* (*operator-controlled*). These enable wagons to be retarded or stopped by remote operation from the control tower. Bars are situated alongside the rail and these are caused to squeeze both sides of the wagon wheel at the pressure required to give the necessary retarding. They may be controlled hydraulically or electro-pneumatically. The retarder operator uses his discretion as to the amount of pressure to apply, but in some yards he is given assistance by devices which automatically classify the cuts according to their weight and by others which measure the speed of the cut—as it descends from the hump—and its rolling characteristics.

In so far as retarders are required for maintaining intervals between cuts, they need to be situated near the hump and a common arrangement is for two *primary retarders* to be placed in the tracks between the king and queen points. Alternatively, one may be placed between the hump and the king points or four may be situated between the queen and jack points. In addition to regulating the interval between wagons passing from the hump to the clearance points, it is customary to use these retarders also to assist with distance braking. But they cannot do it entirely, as wagons which have to travel only a short distance would need to be retarded so severely that the whole rate of shunting would need to be slowed down. Also, various factors such as changes in wind speed and direction affect the running of wagons after this. Therefore additional retarding is required at a later stage. This may be done by brakesmen. If so, less men will be required than at those places where all the retarding is done by brakesmen, on account of the assistance given by the remotely controlled rail-brakes. Alternatively, it may be performed by *secondary retarders*. A common arrangement is for two primary retarders between the king and queen points to be supplemented by eight secondary retarders immediately beyond the jack points (see pages 136-137).

The speed at which a wagon should leave the secondary retarder in order to buffer up to wagons already in the siding at less than 4 m.p.h. depends on several factors:

(i) The distance from the retarder to the last wagon already in the siding.

(ii) The weight of the wagons and the number of wagons in the cut; also the rolling characteristics of the cut—hereafter called *rollability*.

(iii) The curvature of the track in the particular sorting siding.

(iv) Weather conditions.

The retarder operator must take these into account in selecting the pressure to be applied. He may have information supplied to assist him in selecting the correct pressure, such as weight, number of wagons and rollability, and also details of the occupation of the sorting sidings by previous wagons.

(*c*) *Rail brakes or retarders* (*fully automatic*). The information regarding weight and rollability normally supplied to an operator to assist him in selecting the correct pressure can, alternatively, be fed into a computer which will select the correct release speed for each cut from the retarder it controls. Computers controlling secondary retarders also have to be supplied with information regarding the curvature of the siding to be entered and the distance to run, according to the occupation by other vehicles. Provision has to be made on the panel for: (1) modifying the computed release speeds slightly to cover the effect of strong winds; (2) modifying the braking pressure in wet weather when the braking is slightly less effective.

Automatic operation reduces the number of staff required and by replacing human judgment by precise computation enables the work to be carried out with less heavy impacts and less pushing down of wagons which have stopped short.

(*d*) *Automatic wagon control.* The main disadvantage of the retarders is their location some distance back from the point where it is finally required to bring the wagons in each cut to rest. In consequence, a variation in wind speed after the final retarder pressure has been exerted can cause heavy impacts or wagons stopping short. Another complication arises because of the difficulty in establishing precisely the rollability of wagons, which appears to vary within a short time span.

What is really required is a control of the wagon during the whole of its passage from the hump to the point in the siding where it must come to rest. This would be difficult to achieve at an economic cost. There are a great number of sorting sidings, and the rate of wagon entry into a particular siding is low. Therefore, any apparatus placed in a sorting siding would deal with few wagons and would stand idle for a far greater time than it would be in use. Sorting sidings are of considerable length and the idea of employing retarders of the type previously mentioned along their whole length is uneconomic. Retarders alone would

be insufficient, as some boosting apparatus would also be required to deal with wagons that would otherwise stop short.

If a simple and flexible installation could be installed to control wagon movement throughout the sorting sidings this would be advantageous. At the time of writing there is no equipment available at a sufficiently low price to justify its installation.

(4) *Direct transfer from reception sidings to departure end of sorting sidings.* Certain wagons must not be loose-shunted at all; *e.g.*, those containing livestock or very fragile loads. Other wagons may not be suitable for retarding with rail brakes (*e.g.*, those with wheels of unusual thickness); these are normally called *non-retarders.* Wagons in both these groups, together with other wagons which it is desired to place at the front of a departing train for any reason, should be marshalled on the incoming train next to the locomotive. Instead of the locomotive being detached, uncoupling should take place behind these wagons and the train engine should transfer them direct to the departure end of the yard before going to its next job. Alternatively, wagons requiring transfer by locomotive, instead of being loose-shunted, may be marshalled on the rear of the train, and the transfer may then be done by the shunting locomotive after the remainder of the train has been propelled to the hump. This avoids a disturbance to humping which would result if the wagons arrived in any part of the train.

(5) *Wagons detached from, and attached to, through trains.* To minimize delay, arrangements may be made for trains to call at a marshalling yard to detach a portion or to pick-up a number of wagons (or both). Such trains do not use the main reception sidings but normally detach wagons for the yard at the departure end of the sorting sidings. These wagons are placed into the appropriate sidings at the departure end by the train engine or a shunting engine.

Departure Process

Without automatic couplings, the connection of couplings and vacuum pipes of unconnected vehicles in the sorting sidings is an expensive and prolonged operation. As it is necessary for the person coupling the vacuum pipes to enter between the vehicles, care must be taken not to shunt more vehicles into the siding while this work is being done. At the same time, if trunk trains are to leave as soon as their loads have been assembled, it is not desirable for the coupling together of all the vehicles on the train to be delayed until the last vehicle has been shunted in. Examination of wagons for defects and unsafe loading is desirable in the sorting sidings to avoid mishaps on the running lines.

The brake van and locomotive should be joined to the train as soon

as shunting, including secondary shunting if necessary, has been completed. The engine is then required to create the necessary vacuum on the train brake, and the train is ready to depart.

COMMUNICATIONS

As with other installations an effective communication system is necessary and it may include several of the following features:

A wide loud-speaker coverage.

An automatic intercommunication telephone system.

Telephone and teleprinter connections with the Control office, other yards and the national telecommunication system.

Radio communication between the shunting locomotives and the control tower, and between the shunter cutting-up and the tower.

Pneumatic tubes between various points on the reception sidings and the control tower.

A centralized signalling system operating colour-light signals.

SHUNTING ENGINES

The selection of the type of shunting engine to be used is determined by the weight of the trains to be dealt with and the gradients to be negotiated. Desirable features are: (1) rapid acceleration and deceleration; (2) good braking power; (3) quick-acting reversing gear; (4) good visibility from the footplate; (5) low running costs; (6) ability to work for lengthy periods without interruption for fuelling or maintenance. The diesel locomotive is superior to steam locomotives on each of these counts. Single manning and smaller charges for maintenance and fuel result in substantial saving, and most diesels can work up to a week without needing more fuel or attention.

As the shunting locomotive spends most of the time propelling trains instead of drawing them, the problem of reading signals is greater. The humping signals which tell the driver to propel towards the hump or to stop may be difficult to see, particularly during fog. It is necessary, therefore: (*a*) to repeat signals at intervals along the reception sidings; or (*b*) to give audible signals from points along the sidings; or (*c*) to provide cab signals. These repeat the aspects of the humping signal inside the cabin of the shunting locomotive. Transmission of the signals is performed through track circuits, which extend the length of the reception sidings, and special receiving apparatus on the locomotive.

Use of Train Locomotives for Shunting. If some train locomotives and crews have long turn-rounds at marshalling yards it may be possible to use some of this time in shunting, thereby reducing or eliminating shunting-engine hours. This arrangement has disadvantages

including: (*a*) late arrivals of incoming trains may leave yards without a shunting engine at a vital time; (*b*) an engine designed for train working is not as efficient in shunting as a shunting engine.

THE USE OF MARSHALLING YARDS

AVOID WAGONS ENTERING YARDS UNNECESSARILY

As interruption to movement is inevitable when wagons enter marshalling yards, they should only pass through yards when it is unavoidable. Therefore, the freight-train pattern should provide for through services between terminals and/or private sidings wherever possible. This not only avoids delay in the marshalling yard, it also reduces the cost of dealing with the wagons. A wagon which has to enter a marshalling yard must bear a proportion of the cost of running that yard. Those costs, it has already been established, are formidable. By keeping out wagons which need not enter, those that must pass through can be handled expeditiously.

The need for more detailed records of wagon movements has been mentioned elsewhere. In the absence of these, the best method of preventing wagons from entering yards unnecessarily, is by the use of periodical checks at marshalling yards; these checks are usually called Freight Traffic Analyses.

Use of Freight Traffic Analysis. During the period of the analysis a record is taken of all wagons arriving in the reception sidings. This record shows the following details: wagon number; whether loaded or empty; originating and destination stations; details of load, date of dispatch and route—as shown on the wagon label; date and time of arrival in the yard; details of train by which conveyed; whether fitted with vacuum brakes. A similar record is taken at the departure end of the yard, showing the details of the train on which each wagon departed.

As the record has to be made over a number of days if it is to be effective, a great mass of information is acquired, and before it can be used it must be analysed. It has many uses, which includes bringing to light wagons which are entering the yard to no purpose. At yard "*B*" the record may reveal wagons coming in *en route* from "*A*" to "*C*" between which points there is already a service and which would afford a quicker transit for the wagons. In this case, the working at yard "*A*" should be investigated to find the reason for the staging. *Staging* is the term normally applied to wagons which are sent to intermediate yards instead of being sent by direct service to destination. Alternatively, although there is at present no through service between "*A*" and "*C*,"

the census may reveal that there are sufficient wagons passing to justify the introduction of one, thus enabling all wagons to pass between these two points without entering " *B*."

Even if the census reveals only the nucleus of a through train, it is worth while to consider it. The quicker transits and improved service which will result from its introduction may well attract more traffic which has not passed by rail hitherto. The examination of the analysis should proceed until it has been established that there is good cause for the entry of all wagons, which will still be permitted to enter. By continuing to apply these methods it is sometimes possible to close individual yards, bringing substantial economies.

REDUCE THE TIME WAGONS SPEND IN YARDS

Having reduced the number of yards to a minimum and restricted entry to them to those wagons which must enter, the next step is to ensure that the least interruption to movement is suffered by these wagons. The extent of detention to wagons in yards is not always appreciated. There must be some on the reception sidings until the engine is released, and cutting up and examination have been finished. Then there may be a lapse of time before shunting of the particular train begins.

In the sorting sidings, the first wagon into the siding must suffer a longer wait than later arrivals. This raises a most important point in relation to the use of yards. Yards must be equipped and operated to suit the traffic, rather than the traffic regulated to suit the yard working. Because yards are expensive to operate, there is a temptation to say that the traffic must arrive in a steady flow to keep the yard equipment continuously employed. If this is done, the overnight transits, which are the key to a satisfactory merchandise service and to reduced over-all costs, are impossible. A simple example will illustrate this point.

EXAMPLE. Yard " *Y* " deals with 2,400 wagons a day. Evenly distributed this represents 100 wagons an hour. If these are spread evenly over 25 sorting sidings, there is an entry of only 4 wagons an hour into each siding. Therefore, if departing trains are of only 40 wagons it is approximately 10 hours between the first wagon arriving in the sorting siding and a train load being completed.

Delays of up to 10 hours in the sorting sidings are not tolerable if a reasonable service is to be given, and therefore it is necessary to deal with traffic at a much higher rate than 100 wagons an hour at the peak times in order to build up train loads more quickly and to reduce the delays to wagons. The price to be paid is the equipment standing idle at the off-peak times. The extra expense involved at " *Y* " is likely to be more than offset by increased traffics resulting from better service and better use of freight rolling stock.

The wait in the sorting sidings can, therefore, be reduced by:

(1) Increasing the shunting rate at the peak times. If the marshalling yard is near to the terminals and private sidings there will probably be a frequent arrival of feeder services conveying wagons from these points during the evening.

(2) As soon as these wagons have been shunted into their respective sidings, the trunk services must leave.

The freight traffic analysis details are useful again. These will show the time of arrival in the yard of the wagons for the various trunk services. This will give an indication of the time at which the trunk train may be booked to leave, having made an allowance for the reception, shunting and departure processes previously outlined. By careful integration of arriving and departing train times to form quick connections, the wait in the sorting sidings can be brought to the lowest level.

AVOID DAMAGE TO WAGONS OR CONTENTS

Some of the problems of retarding wagons satisfactorily have already been discussed, in particular the varying rollability which can result in heavy impacts. However, as reliable service is the aim, there must be constant attention to this matter.

Where there is human intervention such as the employment of brakesmen or retarder operators, these staff need to be carefully trained. They must be made aware of the consequences of heavy impacts which result from their lack of care. An important step is to establish responsibility for heavy impacts. This can readily be done where damage to the wagon is caused, or where the load on an open wagon is displaced, providing there is an examination of wagons for defects on the sorting sidings, as well as a wagon examination on the reception sidings. The latter establishes that the wagon was undamaged on arrival in the yard. If it is found to be damaged or the load disturbed when examination is carried out in the sorting sidings, providing the damage is consistent with heavy impact, the retarding appears to have been at fault. As the retarder operators or brakesmen responsible for retarding in that sorting siding can be traced, according to the time the wagon was shunted, responsibility can be placed upon the individual concerned.

PROMOTE THE MOST SPEEDY SUBSEQUENT JOURNEY

In addition to reducing the time spent in a yard, and the damage caused in the passage of a wagon through the yard, its subsequent transit can be influenced by the way it is dealt with in the yard. This may be done by:

(*a*) Sending wagons direct to destination if possible and avoiding

unnecessary staging. Traffic analysis plays another important role here. The despatch details of the analysis will reveal if there is scope for the introduction of additional through trains, thereby reducing staging. If traffic cannot go direct to destination it should pass through the least number of marshalling yards after leaving the yard under discussion.

(*b*) The prompt despatch of trains. Failure to send a train away punctually may not only jeopardize the transits of the wagons on that train but also the transits of wagons on other trains. Departures are often in close series and a late start to one of the trains in the series may set back all the others scheduled to depart immediately after it. Reactions on the running lines may spread delays far and wide.

(*c*) Ensuring the highest classification of departing trains. Advantage should be taken of the vacuum-brake wagons available. When a train consists partly of fitted and partly of unfitted wagons, the former should be marshalled next to the locomotive and the pipes connected to it in order to make the maximum brake power available to the driver. This increases safety in working and may also permit the train to travel safely at higher speeds than it could with a smaller braked portion. A good indication of the proportion of fitted wagons conveyed by each train and therefore of the best classification at which each may be scheduled is given by the freight traffic analysis details. If the opportunity arises from day to day to improve on the scheduled classification, advantage should be taken of it, as a better speed potential than that scheduled helps in recovering time after delays.

KEEP WORKING COSTS DOWN

Effect of Marshalling Yards on Train Working Costs

At the beginning of this chapter it was stated that marshalling yards are expensive to operate. Later it was said that yards must be capable of dealing with daily peaks if overnight transits were to be given. This tends to inflate costs still further because equipment and staff is underemployed outside the peaks. But having accepted that yards are expensive and also that they must meet traffic requirements, it is still necessary to avoid unnecessary expense in their operation and to keep costs to a minimum without detriment to transits. The most important step is to employ the minimum number of yards, as unnecessary ones lead to poor service and high costs.

Within a particular yard there are contributions to be made to a reduction in general operating costs as well as in keeping down the costs of the yard itself. Already the prompt acceptance of trains on to the reception roads, the immediate release of train engines from the reception roads, and the prompt despatch of trains from the sorting

sidings have been mentioned. Each contributes to the " keep it moving " principle, which is the basis of low costs. Similarly, reducing the time that wagons spend in yards reduces freight-rolling-stock costs.

The size and location of yards influences the size of train loads and therefore affects train working costs. Having fewer large yards in place of a greater number of smaller ones often increases the distance from the originating point to the marshalling yard and, in consequence, the average length of feeder services increases. As feeder services by their nature are frequently lightly-loaded trains this increases train working costs. Against this can be offset the economies which derive from the better loading of trunk services from the larger marshalling yards. As they draw in traffic from a larger area, it is possible to load trunk services closer to the locomotive capacity than can be done from smaller yards. In planning new yards these two considerations must be weighed against each other.

Marshalling-yard Costs

Mechanization of point setting and retarding improve the quality of the service and at the same time enable the number of staff employed to be reduced. The mechanized equipment introduced to replace the staff is often complex and expensive. When the savings in wages are set against the interest on capital and the maintenance costs, they may not appear to be of great consequence. But the return on the investment is likely to increase as the years pass, on account of the tendency of labour costs to continue to rise.

Shunting locomotive costs often account for a substantial part of the yard operating costs. In addition to those locomotives propelling trains over the hump or projecting wagons into the sorting sidings, others may be employed for secondary sorting, and for making transfer trips between yards or between parts of the same yard.

Shunting engine analyses should be carried out regularly. In a shunting engine analysis a record is taken of the various work done and also of time standing idle. Each time the shunting engine does not move for a period of time an explanation should be recorded. In analyzing these records it can be established if the correct number of locomotives is being employed, and if the hours of employment may be reduced for any of them. Where shunting locomotives are obstructing each other, the work could possibly be done more efficiently with fewer of them.

In scrutinizing a shunting analysis of a humping locomotive the time occupied is likely to be made up of the following items: (*a*) propelling trains to the hump; (*b*) running round loads in the reception sidings; (*c*) pushing-down sorting sidings; (*d*) correcting wrong shunts; (*e*) waiting traffic; (*f*) signal delays; (*g*) meal breaks; (*h*) other activities.

Item (*a*) represents the main purpose for which the locomotive is provided, and if it appears that undue time is being taken under other headings, the causes should be investigated and the matter put right if possible. Items (*c*) and (*d*) can be most expensive in time, if the retarding arrangements are not satisfactory. If it is practicable, pushing-down, correcting wrong shunts and meal breaks should be arranged to take place during the waiting traffic periods.

Effect of the Peaks. To give a satisfactory service the peaks may be unavoidable, but there are means of mitigating their effects on the costs of yard operation. Traffic which does not need an overnight transit should be dealt with outside the peaks if this can be done without detriment to its service.

Hours of Opening. The hours in which a yard is open affects the staffing costs. It is economical to close a yard for certain parts of the day when this can be done without detriment to transits. Alternatively, parts of a yard may be closed. It is possible to arrange for trains to be received on the reception sidings or to depart from the sorting sidings when the remainder of the yard is closed.

It is necessary to stress again that the yard must suit the traffic requirements. In particular this must be borne in mind at weekends when staff payments are enhanced and therefore the costs of yard operation increase. It is tempting in these circumstances to close a yard without regard to the effect on the transits of traffic. This is a temptation to be resisted for the reasons set out in Chapter 12 (pages 201–202).

SUMMARY

1. *Marshalling yards are expensive to construct, to maintain and to operate. Use the minimum number.*
2. *Provide adequate reception facilities. Release train engines immediately and shunt without delay.*
3. *Yards require many sorting sidings to eliminate staging.*
4. *Clear sorting sidings promptly.*
5. *Departure sidings in excess of requirements are an unnecessary expense and encourage transit delays.*
6. *Progression in one direction through a yard gives best working and therefore single-ended sidings should be avoided.*
7. *Retarding should avoid heavy impacts or stopping short.*
8. *A comprehensive connectional programme between arriving and departing trains is essential for reliable transits.*
9. *Aim for prompt departures.*
10. *To give good transits, yards must suit the traffic, not traffic the yards.*
11. *Avoid wagons entering yards unnecessarily.*

CHAPTER 9

Plan of Operation

In Chapter 1 it was explained that realistic detailed planning was important in making the best use of the units of operation. This reduces the day-to-day improvisation which is, by its nature, less accurate. The planning must be guided by the other principles particularly those which relate to maintaining movement, promoting high speeds, obtaining full loads, and ensuring reliability. The basis of the plan is the Working Timetable (W.T.T.), which is primarily concerned with the use of time and the track. On the foundation of the working timetable, the rest of the plan is built.

THE WORKING TIMETABLE

In planning the timetable the first step is to assess the needs of the customers. No matter how good the plan may be from a theoretical operating point of view, it is of little use if these needs are not met. In making the assessment the timetable planners may make use of previous experience, commercial contacts, surveys, etc., as shown in the following paragraphs.

Previous Experience. From experience there is the knowledge that certain passenger trains are popular and that particular freight trains are well loaded. But it is not sufficient to be guided by impressions or memories, both of which may be misleading. A more scientific method is to use the passenger census and analysis details and also the freight traffic analysis records, both of which have been previously mentioned. The passenger details help to establish which trains are used sufficiently to justify their continuance. Previous use of passenger-train stops at intermediate stations indicates which stops are justified and which should be withdrawn. Freight analyses enable the service to be planned with the minimum number of trains consistent with good transits and the least entries into marshalling yards. They also show the time at which wagons, for the various services, arrive in marshalling yards and therefore the earliest time at which the trains conveying them may be booked to depart.

Although experience of this kind is a valuable guide to the needs of the customer, it is no more than a guide and not too much reliance should be placed on it. A fully loaded train is not necessarily an indica-

tion that the customers are satisfied, nor is the absence of complaints. Similarly, because a train is well patronized when it is scheduled at a particular time, this does not prove that this time is necessarily the most convenient to the users.

Commercial Contacts. The selling side of the railway organization and other representatives in contact with the users and potential users of the service should ascertain the needs of the customers and pass the information to the planning section. They can establish if existing services are satisfactory and what additional services are required to gain traffic passing by other means.

Surveys. Although the sales department should be in regular contact with most users of freight transport, they cannot contact individual passengers. Therefore, passenger surveys are particularly useful. They are normally carried out by interviewers who contact: (*a*) all the users of a particular service on appointed days; or (*b*) a sample of the users; or (*c*) a sample of the potential users of a service. After being summarized and analysed, survey details show the customers' needs and indicate to the planner the type of service most likely to be well supported. They may also show the times most suitable for the majority of people. Surveys are also sometimes useful in connection with freight traffic. They may be conducted by railway staff or consultants.

Knowledge of Competitors' Services. A study of the facilities offered by competing services, often indicates why people prefer to use these instead of rail transport. This may inspire the planner to devise some means of improving railway services in order to gain a greater share of the traffic. Even where the competitor cannot be overtaken in a particular direction the railway may be able to provide advantages in another way. For example, in competing with air lines it may not be possible to provide such a fast journey, but by having a more frequent or conveniently timed service the railway may still gain traffic. In a case where competitive road hauliers have to collect goods early in the afternoon, in order to arrange delivery the following morning, the railway will be in a more favourable position if the train can be timed to leave much later, thus permitting later collection from the senders' premises.

ESTABLISHING WHAT IS ECONOMICAL AND PRACTICABLE

Although a knowledge of the customers' needs is of great assistance to the planner, it is unlikely that these needs can be met in full. Therefore at the same time he must bear in mind factors (1) to (6) which follow.

(1) *Utilization Factor.* It has been established in the Chapters 1 to 8 that the profitability of a train depends not only on how well it is used

and on how much is earned, but also on the cost of running it. The running cost depends to a large degree on the utilization of the various units of operation concerned. Therefore, if a survey shows that the majority of the users of a train want departure at, say, 4.45 p.m. it may still be necessary for it to depart at 4.50 p.m. so that it may be formed by the 4.45 p.m. arrival instead of an extra train being provided for a 4.45 p.m. departure.

The working timetable is the basis of the diagrams (daily work programmes) and rosters of the mobile equipment and staff. But the planning of the train times and diagrams must be done concurrently if the best utilization is to be achieved. There are occasions when the timings must be adjusted in the interests of utilization.

(2) *Point-to-point Running Times.* Transport users want the shortest journey time, and speed is economical to the operator. However, in drawing up the plan, it is necessary to consider what speeds can be achieved regularly by the equipment available. It is not sufficient to define the time required between stations. As the planning advances it is necessary to know how long each class and load of train requires to clear each block section. Then subsequent trains can be scheduled to follow closely behind preceding ones but with clear signals.

Running times, which are used in the compilation of the timetables, are computed taking the following factors into account: type of motive power; load of train; braking distances—these vary considerably on freight trains according to the amount of vacuum-brake power available on the wagons; gradients and curves in each section; permanent speed restrictions in operation in each section. An allowance should be added to cater for adverse weather so that the times should be capable of fulfilment in the normal range of weather conditions.

The running times are listed mainly for the use of: clerks preparing timetables; clerks engaged on timing special trains which run in addition to those shown in the timetable; signalmen and controllers engaged in regulating trains, when the schedules break down for any reason.

Point-to-point allowances have to be defined in one or more of the following forms according to circumstances: start to stop; start to pass; pass to pass; pass to stop. Once correctly established for a particular type of motive power and load, they may be permitted to continue indefinitely until circumstances change. Running times which are too slow lead to inefficient service and tend to increase costs. If too fast, they result in unreliable time-keeping.

(3) *Line Occupation and Terminal Considerations.* After point-to-point running times have been decided upon, a practicable timetable

still cannot be devised until the proposed trains are related to each other. Block working and the desirability that trains should run on clear signals, require a space interval to be maintained between successive trains and between conflicting movements. The availability of platforms at stations must be taken into account. As correlation proceeds, the establishment of the most suitable connections between trains must be decided upon. At the same time, of course, utilization considerations must continue to play their part.

(4) *Recovery Time.* Temporary speed restrictions, which are not incorporated in the point-to-point running times, must be brought into consideration. Recovery time is normally added to the basic running times in order to compensate for the effects of temporary speed restrictions likely to affect train running during the operation of the timetable which is being prepared. Recovery time is also added to point-to-point running times for other reasons. Here is one example. A train may be unable to pass a junction until a particular time because of conflicting movements. Ideally in these circumstances the schedule should be calculated by working backwards from this time. By subtraction of point-to-point running times and intermediate station allowances the latest time at which the train may leave the originating point can be calculated. However, this departure time may not be suitable from a station-working point of view, or for other reasons. If it is necessary to despatch the train earlier, recovery time has to be added to the point-to-point timings in order that the train does not reach the junction too early and thereby be brought to a stand.

The allocation of recovery time for engineer's work is discussed further in Chapter 14 (page 223) and although that specifically relates to passenger train punctuality, similar considerations apply in allocating recovery time to freight trains.

(5) *Sequence of Planning: Train Priorities.* The sequence in which trains are planned affects the standard of service which each class is able to offer. Therefore, although passenger services are less flexible than freight in the matter of timings it would often be detrimental to freight transits to establish the whole of the passenger service and then fit the freight trains into the gaps that remained. However, the correct sequence varies from line to line.

Planning priorities also have to be decided upon within the main groups. For example, fish, fruit, and flower traffic for market merit precedence over less perishable freight traffic. Often it is necessary to begin with the long-distance express passenger and long-distance fully fitted freight trains (the trunk services). These provide the framework on which the national connectional network is built up. In compiling

the priorities one must take into account the benefits, from the line-capacity point of view, of grouping trains of similar speeds and minimizing the difference between the speed of successive trains (see Chapter 2, page 38). A typical sequence might be: (i) express passenger trains; (ii) fully fitted freights; (iii) parcels trains; (iv) stopping passenger trains; (v) partially fitted freights; (vi) other trains.

There must, however, be flexibility to provide for adjustments in these planning priorities when important service or utilization considerations arise in any group. There may be good reasons why a train in group (vi) should take priority in planning over trains in groups (iii), (iv) and (v) in order to make a connection with a trunk service. Similarly a train in group (iv) might merit extra priority to get better utilization of equipment and men. The priority should be influenced by the potential traffic for each class of train and the net revenue likely to be derived from it.

(6) *Sequence of Planning: Route Priorities.* Because of their frequent interdependence in regard to connections, junction workings and utilization, routes cannot be dealt with in isolation. In establishing precedences in the planning of routes one must take into account geographical considerations and traffic density.

Geographical Considerations. The trunk routes which have the greatest number of important intersections with other lines are most difficult to plan. It is easier to devise a satisfactory over-all timetable if the main trunk trains on these routes are planned first, and the services on the lines radiating from them are scheduled to give the best connections into and out of them.

Traffic Density. Those lines with the densest traffic merit some priority in relation to less heavily occupied sections, as on the latter there is more room to manoeuvre.

MAKING THE TIMETABLE

Use of Train Graphs or Computers. Detailed planning of one train in relation to another must be done on a route or a district basis. There are obvious advantages in the planning of one route being performed by one individual. But with exceptionally long or busy routes this may be beyond the capacity of a single person, and it may be necessary to divide it into several parts. This necessitates consultation and agreement regarding the timings at the points of division. Similar agreements are required when two routes which are planned by different individuals converge. The junction point must be under the control of one person only, in order that the working can be properly integrated.

Graphs are normally employed in the planning of trains in relation

to each other. A separate graph is required for each route. The horizontal axis is a time scale, and the vertical axis is graduated according to the length of the block sections, as shown on Plate 29.

Trains are represented on the graphs by lines drawn from point to point in accordance with the speed of the train. These are known as train *paths*. Between successive trains adequate headway (see Chapter 2) is allowed to permit trains to run under clear signals. The graph may be used to illustrate platform occupation as well as line occupation and in these cases this is the foundation of the Station Working Booklet (see Chapter 6, page 101). Where there is more than one running line in each direction, the trains on the slow or goods lines may be indicated by different colours or by disjointed lines. The lines representing the trains are identified by the train number or by other devices.

It is not customary to show all shunting movements on the graph and therefore line occupation by trains must leave sufficient opportunity for shunting to be done at the time it is needed and without causing interruption to train movements. Both Up and Down trains are normally drawn on the graph as this helps the timing clerk to maintain adequate space intervals between conflicting movements at flat junctions. Separate graphs may be required for Mondays to Fridays, Saturdays and Sundays.

In order to reduce the manpower required in timing offices and to speed up the production of train paths, electronic computers may be employed. A suitable machine fed with information regarding point-to-point timings, headway times and duration of train stops can produce properly spaced train paths.

Preparation of Working Timetables. When the plan of train working has been completed satisfactorily on the graphs, it has to be translated into a suitable form so that it may be communicated to the people responsible for carrying out the plan. This is the working timetable. It is necessary for it to be sectionized on a route or district basis. Separate books may be issued for freight and passenger services, or the two may be combined in one book. Whether combined or separate books are best depends on the type of service and local circumstances. Careful sectionizing and the correct decision on combined or separate books help to reduce timetable costs. It also ensures that the recipients of the books are supplied with all the information they require in a compact form with a minimum of irrelevant information.

The planning of a new timetable must begin many months before it is due to be introduced. This is brought about by:

(*a*) The time taken in preparing the graphs and later transferring the times to the draft W.T.T.

WEEKDAYS — **ST. PANCRAS TO**

DOWN	A	B1	B6	B4	B6	B2	B3	C	A	B1	C
	To Nottingham	Diesel	Diesel to Barking	Diesel	Diesel to Barking	Diesel Rail Bus to Northampton	Diesel	8.56 am ECS from Moorgate	To Edinburgh	Diesel Rail Bus	Empty Diesel to Kettering
	63								71		
	♠	SX D4	D4	D4	D4	D2	D4		♠	D2	SO D4
	am	am	am	am	am	am	am	am	am	am	am
ST. PANCRAS .. .. .. dep	8 15	8 20	..	8 35	..	..	9 0	..	9 15	..	..
	FL	FL	SL	FL	SL		FL	SL	FL		
Kentish Town ..... arr	.....	8 24	.....	.....	.....	.....	9 4	9†13	.....	.....	.....
.. .. dep	8 19	8 24½	8 30	8 39	9 0	..	9 4½	..	9 19	..	..
Junction Rd. Jn.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Upper Holloway	..	..	8 35½	..	9 5½	..	..	..	..	..	..
Carlton Rd. Jn.		.....	.....	.....	.....	.....	.....			.....	.....
Finchley Rd.		LL	..	..	..	..	LL			..	..
West Hampstead Mid.		8 29	.....	.....	.....	.....	9 9½			.....	.....
Watling St. Jn.		..	..	..	..	..	..			..	..
Cricklewood ..... arr		8 31½	.....	.....	.....	.....	9 12			.....	.....
.. .. dep		8 32	..	..	..	..	9 12½			..	..
Cricklewood Jn.		.....	.....	.....	.....	.....	.....			.....	.....
Hendon	8 27	8 35½	..	8 45	..	..	9 16		9 25½	..	..
Mill Hill Broadway	.....	8 40½	.....	.....	.....	.....	9 21		.....	.....	.....
Elstree & Borehamwood	..	8 45½	..	8 52½	..	..	9 26½		..	..	..
Radlett	.....	8 50	.....	8 57	.....	.....	9 31		.....	.....	.....
Napsbury	..	..	..	..	..	..	..		..	..	..
ST. ALBANS CITY ..... arr	.....	8 56	.....	9 3	.....	.....	9 37		.....	.....	.....
.. .. dep	8 40	..	..	9 4	..	..	9 37½	..	9 38	..	..
Harpenden Cen.	.....	.....	.....	9 11	.....	.....	9 44½	.....	.....	.....	.....
Harpenden Jn.	..	..	..	..	..	..	..	..	.	..	..
LUTON MID. RD. ..... arr	8 51	.....	.....	9 17½	.....	.....	9 51½	.....	.....	.....	.....
.. .. dep	8 53	..	..	9 18½	..	..	..	..	9 48	..	..
Leagrave	.....	.....	.....	9 23	.....	.....	.....	.....	.....	.....	.....
Harlington	..	..	..	9 29	..	..	..	..	..	..	..
Flitwick	.....	.....	.....	9 33½	.....	.....	.....	.....	.....	.....	.....
Millbrook	..	..	..	..	..	..	..	..	..	..	..
HITCHIN ..... dep	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 40	
Hitchin Goods	..	..	..	..	..	..	..	..	..	..	
Henlow Camp ..... arr	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 47½	
.. .. .. dep	..	..	..	..	..	..	..	..	..	9 48	
Shefford	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 52½	
Southill	..	..	..	..	..	..	..	..	..	9 57	
Cardington	.....	.....	.....	.....	.....	.....	.....	.....	.....	10 3½	
Bedford No. 1	..	..	..	..	..	..	..	..	..	10 7	
BEDFORD MID. RD. .... arr	9 14	.....	.....	9 44	.....	.....	.....	.....	FL	10 9	
.. .. dep	9 16	..	..	..	..	9 49	..	..	10 4	..	10†10

After working 7.57 am from Harpenden

Special Limit

XL Limit

To work 11.5 am to St. Pancras

(*b*) The necessity to reach agreement on the timing of trains passing between two or more timing areas.

(*c*) Later, the cross-checking of these times in the various sectional timetable proofs.

(*d*) The time required by the printer for the preparation and issue of proofs and the printing of the final documents.

BEDFORD MID. RD. 9A

A	G	B	B4	C	G	B6	C	B3	C	G	G	A	A	B2	B4
To Leicester	LE (Diesel)	To Southend	Diesel	9.22 am ECS from Moorgate	LE (Diesel)	Diesel to Barking	9.40 am ECS from Moorgate	Diesel	ECS	LE	9.50 am LE (Diesel) from Moorgate	To Glasgow	To Manchester Cen.	Diesel Rail Bus to Northampton	Diesel
75												81	85		
	MSX	SO	D4	SX	SX	D4	SX	D4	SO	SO	SX			D2	D4
♠ am 9 25 FL	am .. SL	am 9 30 SL	am 9 35 FL	am .. SL	am .. SL	am .. SL	am .. SL	am 10 0 FL	am ..	am ..	am .. SL	♠ am 10 15 FL	♠ am 10 25 FL	am ..	am 10 35 FL
9 29	9‖28	9 36	9 39	..	9‖55	10 0	..	10 4½	..	..	10 11	10 19	10 29	..	10 39
1	..	9 42	..	..	..	10 5½	..	..	..	..	..	..	..	..	..
Special Limit	9X31 GL			After working 8.23 am from Luton	9X59 GL		After working 8.32 am from Luton	LL 10 9½			10*16 GL	Special Limit	XL Limit		
..	9‖p51				10‖p18			10 12			10‖p35				
								10 12½							
9 38	Brent Jn. No. 2 arr 9*46, dep 9*48 am	..	9 45		Brent Jn. No. 2 arr 10*13, dep 10*15 am	..		10 16	..	..	Brent Jn. No. 2 arr 10*30, dep 10*32 am	10 27	10 35½	..	10 45
								10 21							
3		..	9 52½			..		10 26½	..	..		..	..	..	10 52½
..		..	9 57			..		10 31	..	..		..	..	..	10 57
			..					..		..					..
			10 3					10 37							11 3
9 54	..	..	10 4	..	..	..	..	10 37½	..	After working 10†20 am from Hitchin	..	10 40	10 48	..	11 4
			10 11					10 44½							11 11
2		..	..	..		..	..	..	..		..	..	..	..	..
10 7			10 17½					10 51½	To work 11†6 am to Henlow Camp		After working 8.32 am from Luton		10U59		11 17½
10 10	..	..	10 18½	..	..	..	..	..				10 50	11U1	..	11 18½
	After working 9†56 am from Moorgate		10 23		Ater working 9†22 am from Moorgate										11 23
2			10 29												11 29
10X26 SL			10 33½												11 33½
			..						10†20						
									..						
									10†35	10‖40					
									..	10‖48					
10 35			10 44									FL	FL		11 44
10 39	.	..	..	..	..	..	..	..	..	..	..	11 7	11 19	11 30	..

(*e*) The timetable being required to be published some time before the date of its introduction. Although many of the other planning documents are based on the proof of the working timetable, there is a danger that inaccuracies will arise unless they are checked against the final work.

Information contained in the W.T.T. The working timetable contains more information than the public timetable. It is necessary that details

of all regular trains—freight and passenger, loaded and empty—should be shown for the guidance of the operating staff concerned. Normally, for each train the timetable shows: the class of train; train number; from; to; days of the week on which it runs; departure, passing and arrival times at key points; the running lines on which scheduled to run; recovery time allowed; the purpose of stops scheduled for other than traffic requirements, for example, change of train crews; other information regarding the operating arrangements. The working timetable also shows the distances between stations, signal boxes and so on. A specimen page is shown on pages 158-159.

Various miscellaneous information is shown in some working timetables. This may include the route availability of locomotives, breakdown crane arrangements, location of carriage and wagon examiners, opening hours of signal boxes, etc. In other areas information of this kind is published in separate documents.

Dates of Reissue of Working Timetable. A new issue of working timetables is required when a fundamental revision is made of the services covered by the book. As there are often many differences between summer and winter services, it may be convenient to reissue in June and late September. But the dates and frequency of reissues should be flexible to suit the circumstances. Where frequent alterations are taking place, it is desirable to have more than two timetables a year in order to reduce the issue and the size of supplements.

Supplements. If some adjustment to the booked trains is required to improve the service or to cut costs, it is undesirable that the changes should be postponed for some months until the next timetable is issued. Therefore, it is the practice to issue supplements at monthly or other intervals containing such alterations. The circulation of the supplements is the same as that of the timetables which they amend.

It is necessary to avoid supplements becoming too many and too large. Apart from the cost of producing and printing them, they introduce an opportunity for error. A single member of the staff, who has not received his copy of the supplement or who has failed to notice an item on it can, in consequence, make a mistake which seriously upsets the working.

USES OF THE W.T.T.

Communication of Train-timing Details to all Staff Concerned. Personal issues are usually made to guards and drivers of the sections of the timetables with which they are regularly concerned. When they occasionally work over other sections, it may suffice if they borrow a W.T.T. of those sections, or extracts covering them. Station and yard

PLATE 26. *Part of the carriage cleaning plant at South Gosforth (North Eastern Region). The heavy bristle Nylon brushes rotate in both directions at high speeds. In addition to jets from standards in the foreground, each pair of brushes is watered by its own spray.*

PLATE 27. *Railway wagons set up for perambulation purposes at Hull Central Goods Depot (North Eastern Region). The work is protected from the weather, but the glazed roof gives maximum natural light. This is supplemented by artificial lighting.*

PLATE 28. *The Control office at Doncaster (Eastern Region). The section controllers (left) are using the train-card and geographical-board method of train control.*

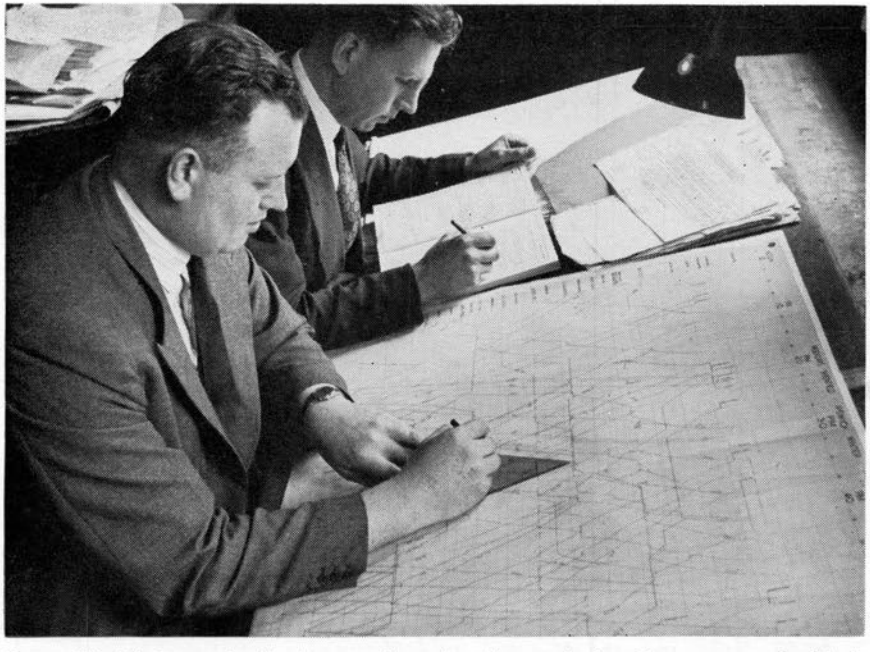


PLATE 29. *Timing trains by the use of graphs. The vertical scale represents the block sections; the horizontal scale is a time scale. Sloping lines represent trains in motion; horizontal lines represent trains at rest.*

staffs, signalmen, controllers and other staff concerned with train working also need to refer to W.T.T.'s, but a personal issue is not normally necessary. There is often a failure to appreciate the cost of copies of the working timetable. Periodical checks should be made of the distribution lists to see if the circulation can be reduced.

The W.T.T. is the Basis for the Public Timetables. That part of the public timetable which gives details of train times is mainly an extract from the W.T.T. But there are sometimes a few differences between the passenger train times advertised to the public, and those shown in the working timetable. These may be introduced for various purposes. One case in which this device is used is to sever connections at junction stations. In the working timetable a train from " *X* " may be due at " *Y* " junction at 6.29 p.m. As this train has come a long distance its time-keeping may not be quite dependable. The absolute punctuality of the outgoing 6.30 p.m. from " *Y* " to " *Z* " may be very important. As there is no appreciable transfer from the " *X* "—" *Y* " train to the " *Y* "—" *Z* " train, it may be desirable for the incoming train to be advertised to arrive at 6.31 p.m. This makes it quite clear that there is no connection between the two trains and by eliminating the dependence of the outgoing train on the incoming one helps towards the good time-keeping of the former.

Another case in which differences in the working and advertised times may arise is when a regular additional train runs on one day a week. This may necessitate on that day a slight modification to the timings of other trains which run daily. To avoid complicating the public timetable, the daily trains may be advertised in one set of times each day. When there is a variation in departure times the advertised times must always be earlier than the working times. If they were advertised later, passengers might arrive too late to catch a train.

The practice of varying public and working timetable times should be resorted to only where absolutely necessary as it complicates the operation of the trains and can lead to dissatisfaction on the part of the passengers. The W.T.T. should show both working and advertised times where there is any variation. The W.T.T. is also the basis of the documents which are issued to traders showing the times of the more important freight services.

The W.T.T. is the Basis of the rest of the Documents which comprise the Operating Plan: diagrams, rosters, etc. Although the planning of staff and equipment utilization should proceed concurrently with the timing, the documents setting out these plans are based upon the information in the W.T.T. For example, in diagrams trains are identified by their W.T.T. timings or by the train numbers shown in the W.T.T.

DIAGRAMMING OF LOCOMOTIVES AND TRAIN CREWS

The W.T.T. shows the number of trains for which motive power and the train crews have to be supplied. It is the job of the diagramming section to plan the work using the fewest locomotives and men compatible with the provision of a good service. This is most efficiently done, where the timetable is built up on a basis of good utilization. When the timetable is completed it is necessary to ensure that all trains have been covered and that the timings shown in the W.T.T. and the diagrams agree. The diagrams should provide for quick turn-rounds but at the same time the turn-rounds should be sufficiently long to permit the fulfilment of the duties that have to be performed. This is particularly important with steam locomotives which may require turning, re-coaling, watering, cleaning of the fire or other attention between trips. The longest runs possible are desirable to keep down costs and because short runs involve an interruption to movement. This is particularly important with locomotives.

As with timing, the best results are likely to be obtained when one individual is responsible for planning over the longest section of line or largest area. Limitations are imposed by what one person can do. The size of area which can be dealt with by an individual may be extended by separating the responsibility for diagramming of freight and passenger trains. However, splitting in this way may lead to inadequate co-ordination between freight and passenger workings. The best method depends on the circumstances; in particular the proportion of multiple-unit workings involved and to what degree mixed-traffic locomotives are used. Whether responsibility is divided geographically or according to the type of train, there must be close liaison between the diagramming clerks concerned. Owing to the interdependence of locomotives, multiple-units, coaching stock and trainmen, the responsibility for planning their use should not be divided any more than is unavoidable.

Guards Diagrams. Freight guards are normally allocated to marshalling yards; passenger guards to stations. Separate diagrams are issued for freight and passenger working. Although freight guards may be scheduled to work passenger trains, passenger guards may not, at present, be diagrammed to work freight trains. This increases the costs of operation and reduces flexibility in working which is such an important attribute if efficiency is to be achieved.

Locomotives and Locomotive Crews. Locomotive and crew workings may be combined in a single diagram or may be issued separately. When they are separate they need to be cross-referenced in order that the relationship between them may be readily established. A loco-

motive diagram shows (i) the name of the motive-power depot required to supply the locomotive; (ii) the number and type of locomotives required to do the work shown in the diagram; (iii) the scheduled departure time from the motive-power depot; and (iv) a list of all trains covered by the diagram. A men's diagram in addition shows time on and off duty, the number of hours and minutes on duty and details of work other than train working which the crew may be required to do; e.g. preparation or disposal of locomotives and so on. Locomotive crews receive additional payments, providing they work more than a specified mileage in a shift. It is in the common interest of management and men that maximum daily mileages should be planned.

Limitations on Engine Workings. A number of limitations restrict the diagramming clerk in his efforts to keep the motive power moving. These were discussed in Chapter 5 and include: availability for traffic purposes; general utility factor, including the availability to work freight and passenger services; route availability. It is also necessary to bear in mind the interdependence of operating units. At terminal stations without release facilities for locomotives, the locomotive working is bound up with the carriage working. A locomotive cannot take up its next train until it has been released.

Limitations on Men's Workings. It is desirable that a single train should be subjected to a minimum of crew changes. The longer a crew stay with a train the greater is their interest in its punctuality. This is a further reason for one diagramming clerk planning locomotive and men's diagrams.

The various agreements made between the railway management and the trade unions impose restrictions on efficient diagramming. The guaranteed day agreements are one example. A man rostered for a shorter period than the guaranteed day, must be paid for the full period. In consequence, efforts must be made to occupy the whole of the day with productive work. Rosters must not normally extend beyond the guaranteed day period. A few, which only slightly extend beyond it, may be accepted by the men's representatives at appropriate overtime rates of pay. The diagram must normally provide for the man to start from, and finish at, his home depot. On suburban lines there would be merit in " split turns " in order that a train crew's turn of duty could cover the morning and evening peaks instead of just one of them. These are unlikely to be acceptable to the staff, without substantial compensation for the additional travelling involved between home and work.

Some advantage is derived from keeping engine and enginemen working together. But the necessity to get men back to their home depot within 8 or 9 hours is incompatible with the through runs which

make the most economical locomotive workings. On longer journeys, when approximately the half-way point in the men's guaranteed day is reached, it is necessary for another crew to take over, i.e., " to relieve." Part of the art of diagramming consists of trying to find productive work to occupy the crew who have been relieved, on their return journey. If suitable work cannot be found, the men must return as passengers to their home depot. Although time travelling as a passenger is unproductive, it has to be paid for. Diagrams which require train crews to work from their home depot to a specified point and then to work back again are known as " Out and Home " Workings.

A few freight trainmen's diagrams may provide for two trains going in opposite directions to stop at whatever point they happen to cross and for the crews to change over. Out and home workings are normally preferable to changeovers as they represent more precise planning. They can provide for stops at the most convenient places. They also provide an incentive for good time-keeping on the outward run as this gives the train crew the maximum break before working their return train.

When single-manning of locomotives is desired the restrictions are more severe. Limits are imposed on the mileage which a driver may work and on the number of hours which may be spent on driving within the guaranteed day. The agreement also defines in which part of the shift a meal-break should be given to the driver. Single-manning during the night hours is forbidden by the same agreement.

A few " lodging " turns are worked. These avoid the necessity to diagram the man back to his own depot each night. Usually he is rostered to reach his home depot on alternate nights. Lodging turns are particularly useful on long-distance work. They avoid interruption to train movements for relief purposes and keep locomotives and men together. Where they do not exist, it is often necessary for long-distance trains to stop specially for train-crew relief, which extends journey time and increases line occupation problems. The limitations on lodging is one of the factors which places the railway in a disadvantageous position compared with road haulage, as in that industry lodging is commonplace.

With locomotives it was seen that there was a problem of route availability. With men a similar limitation applies. Train crews can only work unassisted over those routes where they are thoroughly acquainted with the signalling lay-out. This is referred to as route or road knowledge. Diagrams should be designed to ensure that the route knowledge already held by men of a particular depot is maintained by periodical working over that route. When it is desired to use them to

work over other routes, one must be satisfied that the expense of learning the new route is justified and that it may be completed before the diagram is introduced. Train crews may be permitted to work over routes of which they have no knowledge, providing they are accompanied by pilotmen who read the signals for them.

Unbalanced Workings. When an engine works a train in one direction and has to travel light (without a train) in the opposite direction it is said to be unbalanced. Where the timings are suitable, instead of travelling light it may be advantageous to book the unbalanced engine to double-head a train. This reduces line occupation and gives the train concerned extra power which may prove useful.

The same description is applied to train crews who travel as passengers on one leg of a diagram. It is useful to draw up a list of unbalanced workings for each route, with unproductive trips for the Up route on one side and those for the Down route on the other. This will show at a glance if, through an oversight, unnecessary light-running or " travelling passenger " has been scheduled. After any such errors have been rectified the list will show the spare capacity available for running any additional trains which may be required. This is useful when planning special or additional services.

Obviously the aim should be to keep light-running of locomotives and train crews " travelling passenger " to a minimum. Sometimes it will be inevitable owing to the lack of balance in the traffic. On other occasions it may be a method of achieving the aim of doing the work with the least numbers of locomotives and men. Guards may be used to assist in sorting parcels or mails or for other duties, rather than being booked to travel as passengers.

Unproductive Time in Diagrams. The operator must always regard the unproductive time of locomotives and train crews as a challenge. He should be constantly re-examining his method of working with a view to reducing it, and thereby decreasing the number of units required. For example, if a locomotive cannot be kept employed he should establish the reason. The track over which it should run may be fully occupied. But it has been shown in Chapter 2 that line capacity is not a fixed quantity. Alternatively, a train crew may be unemployed for part of a shift because there is no traffic to be moved. In this case it may be possible to make empty-stock movements, to divert traffic from another route, or to alter the time at which the traffic is available for moving.

Cyclic Diagrams. Although train crews require to be rostered back to their home depots daily, or on alternate days with lodging turns, the same considerations do not apply with locomotives and multiple-units.

Cyclic diagrams are those which cover a cycle of up to four or five days before the return to the home depot for maintenance. Then the sequence is recommenced. Therefore, they require a corresponding number of units to cover them. Cyclic diagrams often enable much better utilization to be achieved and reduce light-running. On the debit side, cyclic diagrams are more complicated and present some maintenance problems. The cancellation of a single train within the period of the cycle, or a mechanical failure within this time, complicates matters further. They are more difficult to amend, and present particular problems when modifications to the train service is involved as, for example, at Bank Holiday week-ends.

Period of Reissue. Diagrams are normally reissued to come into operation concurrently with each new timetable. They should be distributed in good time before the date of operation. This gives an opportunity to adjust engine allocations. Motive-power depot masters can establish what they are required to supply. It also permits the local yard masters and station masters to ensure that all trains have been provided with locomotives and crews in the diagrams. The detailed working of the depot, yard or station can then be planned. The local officials should satisfy themselves the that plan is workable. Their knowledge of local conditions qualifies them best to judge this. Any difficulties or omissions pointed out by them can be put right before the diagrams are due to be introduced.

CARRIAGE WORKINGS

The basis of planning carriage workings, which may also be known as carriage diagrams, carriage rosters, carriage rolling stock diagrams, etc., has already been referred to in Chapter 4. In that Chapter the benefits to be gained from standard formations were also listed. Consistent with economy, attaching and detaching must be reduced to a minimum. When this is unavoidable, the changes in formation must be clearly shown in the diagrams and arrangements made to balance the vehicles concerned. Carriage workings must also show the various services covered, the tonnage of the vehicles concerned and the number of first- and second-class seats conveyed. Some carriage workings show at which points the various types of cleaning should be done. In other places this may be shown in a separate document.

THE REMAINDER OF THE PLAN

Other documents which form part of the regular plan and which are based on the working timetable include: rosters for travelling ticket collectors and travelling cleaners; Post Office mails schedules; marshal-

ling and sectionizing instructions for parcels vans, etc.; station-working booklets; marshalling instructions for freight trains; booklets showing the opening and closing times of signal-boxes.

SPECIAL TRAIN ARRANGEMENTS

In addition to the regular trains shown in the W.T.T., special or additional trains are frequently required. This may be on account of special parties, excursions, extra trains for sporting events or other heavy traffic flows. Usually with passenger traffic and sometimes with freight there is sufficient notice for the paths and other arrangements to be worked out in advance. The plans are then circulated to all concerned by means of a weekly printed special traffic notice, by circular or by other means.

When it is apparent that a timetable passenger train is likely to be inadequate to cope with the traffic offering, a relief train or trains may be added to the programme. A relief train should normally precede the train it is intended to supplement in order to attract the maximum number of passengers and avoid overcrowding of the regular train.

The paths are worked out on graphs which are replicas of the W.T.T. graphs, although sometimes the less important freight services are not taken into account when special passenger trains are being timed. Computers may be used for this purpose instead of graphs.

One of the greatest problems which arises in planning special trains is that requests for trains over a particular line on a particular date are submitted at various times. If the applications are dealt with as they arise, the planning is done on a piecemeal basis and the most efficient use is not made of line capacity, etc. It may also result in the line capacity being completely used up by trains for which early application was made but which are of only marginal profitability, to the exclusion of more profitable trains which are applied for later.

It is necessary, therefore, in certain cases to define a deadline date for the submission of applications for special trains, and to delay quotations of timings until after this date. This needs to be sufficiently early to enable party organizers to make their arrangements, and to permit adequate publicity to be given to any speculative excursions in the programme.

Certain additional services are required frequently but irregularly at particular times. It is advantageous if the paths for these trains are worked out with the regular train paths and are then shown in the W.T.T., to operate as required. They are normally identified with a letter *Q*. Where they can be worked by unbalanced locomotives, or

men, employed in the regular diagrams, this should be shown for the guidance of everyone.

To reduce the heavy work involved in preparing special train programmes for the main holidays at Easter, Whitsuntide and August Bank Holiday, a standard programme should be arranged as far as possible. This cannot be done to the same degree for Christmas because the volume of traffic varies according to the days of the week on which the dates fall.

Special trains affect the whole of the plan and require modifications or additions to be made to diagrams, platform workings etc. Unbalanced units should be utilized where this is practicable, before introducing additional units. Trains required at short notice are arranged by the Control office.

Sticking to the Plan. Everything that can be planned in advance should be settled in advance. This permits the most efficient and economical method of working to be devised. After all this care in planning has been taken, it is good sense to strive for adherence to scheduled working. It will be appreciated, for example, that time is wasted by train crews, who are working to the directions of the Control office, in getting in touch with them for their instructions.

SUMMARY

1. *Planning gives the best results.*
2. *Planning must be realistic.*
3. *The first consideration is the needs of the customers.*
4. *The best utilization results when diagramming considerations are taken into account while timing is in progress.*
5. *Engine and train crew changes during a journey should be avoided where possible.*
6. *Planning priorities must maintain a proper balance between freight and passenger services.*
7. *The various parts of the plan should be distributed in good time before they commence to operate.*
8. *Only essential amendments to the plan should be published.*
9. *Making the plan involves much trouble and expense: when it is introduced—Stick to it.*

CHAPTER 10

The Work of Control

We live in an age in which control offices of various kinds are fashionable. Modern communications have facilitated their development. The executives of various industries are proud of their control offices. When visitors are shown round the premises, the visit to the control office is often the highlight of the tour. Charts and maps surround the wall and brightly coloured discs are moved from place to place in an impressive manner. The staff employed in the control office are naturally delighted to work in the showpiece of the establishment and have the normal tendency to magnify the importance of their jobs.

It is necessary therefore, to examine railway Control offices critically to ascertain if they are justified. Inevitably they are expensive to instal and to operate. They demand an extensive communications system which requires a good deal of maintenance. In addition, they are manned with staff earning fairly high salaries. Is this expense justified in view of the elaborate planning, described in Chapter 9, which goes into the preparation of a railway service? Railways ran for 80 years or so without Control offices. Do they now effect such improvements that there is an adequate return on the cost of running them?

The answer is that on most lines an efficient Control can pay handsome dividends. On other lines, particularly those where traffic is light, Control may not be justified. Even in the first group it may be possible to dispense with Control at certain times of the day or at week-ends when traffic levels fall. Like every other part of the organization, Control should justify its existence by the results it achieves. Before considering the best means of doing this it is necessary to define what is meant by Control, and to consider the purposes for which it may be needed.

A Control office is a focal point from which operations are directed, on the basis of current information supplied to it. It cannot do its job efficiently unless it gets adequate and up-to-the-minute information on the current situation.

PURPOSE OF CONTROL

Considerable effort and expense is incurred in compiling the plan of operation contained in the W.T.T. and the related documents. Because

it is a considered plan, which should have been prepared in a scientific manner, the highest efficiency is likely to be obtained when it is adhered to. Therefore, the first duty of Control is to ensure that the plan is permitted to operate without unnecessary departures from it. When divergencies from it occur, the Control should restore the booked working arrangements as soon as possible.

There are, however, occasions when the plan must be modified. Various emergencies may arise. For example, some obstruction to a running line may occur, which necessitates the diversion of trains, and other adjustments to the service. A Control office should be adequately equipped with communications and with knowledge of the current situation, to enable it to make the necessary adjustments with the least detriment to the standard of service offered and at the least cost.

Modifications are also called for to meet traffic fluctuations. A heavy surge of traffic in a particular direction may require an intensification of the train service. Where there is a temporary decline in traffic levels, it may be possible to work with less trains than the number specified in the plan. Departures from the scheduled arrangements and the provision of motive-power and train crews for purposes other than those booked must be made only through the Control.

LEVELS OF CONTROL

There is usually one Control office for each operating district. On account of the interdependence of the districts brought about by inter-district trains and inter-working of locomotives and men, Control at a higher level is also usually needed. This may be a Line, Divisional, or Regional Control. These will be referred to as Headquarters Controls. At the higher levels, working between districts is co-ordinated and a proper balance between the district requirements is maintained. District Control must consult Headquarters Control before altering inter-district working arrangements which affect more than one other district. Where only two districts are concerned the arrangements may be adjusted after direct consultation between the two. Where Divisional or Line Controls are employed, a Regional Control may still be required to settle conflicting interests between the Divisions or Lines.

It is the intention to concentrate here on the function of the District Control, which is closest to the actual operations. Some of the observations made will apply equally to Control at the higher levels.

MANNING OF CONTROL OFFICES

It is clear that the staff employed in Control work should be capable of making quick, sound decisions on the basis of the information fed to

them. Equipped with this information it is necessary that they should think and plan ahead anticipating how the situation is likely to develop. Planning ahead and anticipating trouble before it arises is perhaps the most important part of Control work. Staff are required who have those qualities which will enable them to do this. They also need an intimate knowledge of the layout and booked service of the district or section with which they are concerned.

The measure of their success largely depends on the degree of co-operation which they receive from the outside staff. This will be forthcoming if the Control staff also have ability in leadership. In exercising their qualities of leadership it is important to leave some initiative in the hands of the outside staff so that they may make use of their own skill and experience. Although it is the Controller who is ultimately responsible for directing operations, if he is prudent he will not fail to exploit the abilities of the outside staff with whom he works. The Controller should also avoid becoming autocratic. Although his decisions must be firm, it may be advisable on occasions to explain the circumstances which have influenced him to direct that a certain line of action should be taken.

ORGANIZATION OF CONTROL OFFICES

Chief Controller and Chief Trains Clerk. To co-ordinate the work of the shifts, which are normally three in number to cover each 24 hours, a Chief Controller is needed. The best organization provides for the Chief Controller to combine the function of Chief Trains Clerk. In the latter role he is in charge of the Trains Section of the District Operating Office. This Section makes the plan of operation. The Control make the amendments to it. The chief controller and chief trains clerk is, therefore, responsible for the plan and for any variations made to it. Concentration of these functions in one man ensures that responsibility is undivided. This is important in most respects of business management. It is certainly beneficial in efficient railway operation.

Deputy Chief Controllers. The Controller in charge of each shift in a Control office is normally described as a Deputy Chief Controller. He is responsible for the efficient operation of the district on his shift, as the agent of the District Operating Officer. He supervises the work of all the sections and the office in general and ensures that the various Controllers on his shift work in unison. He is responsible for the maintenance of a good liaison with other districts and Headquarters Control. He should deal personally with the more important matters. When accidents occur he is often the senior official in charge until the superior officers arrive and his role is a particularly important one at these times.

He should take an interest in the training and development of the staff on his shift. The better this is done, the more efficient they will become and the less exacting his own task will be in the future. The building up of a good team spirit within the Control, and between the Control and the outside staff is an important duty. If done successfully it is likely to result in a standard of working which will fully justify the existence of the Control.

Section Controllers. Ideally a Control district should be under the direction of one Controller, as the division of responsibility creates a number of difficulties and could result in loss of efficiency. In practice, Control Districts are usually too large for one man to direct and it is customary for them to be divided into sections, each under the supervision of a Section Controller. The size of the sections must be governed by the density and flow of traffic.

Section controllers are responsible for the maintenance of efficient train and traffic working on their Sections. They receive and record information from the outside staff and are in immediate contact with all those to whom it is necessary to issue directions.

Train-crew Controllers. Where separate guards' and enginemen's controllers are employed, a close liaison between the two is necessary. There is considerable interdependence between guards, enginemen and locomotives and therefore where it is possible for all three to be under the direction of one person, advantages are derived.

Train-crew controllers are concerned with adjustments made to the plan of operation, and must be kept informed by the section controllers of such alterations. The amount of diagram adjustments that they are obliged to make also depends on the time-keeping of scheduled services and they must be kept informed of the situation. Train-crew controllers must also be in contact with the points where men sign on duty and be prepared to make alternative arrangements in the event of a man failing to report at his booked time. In certain Control offices the section controller may do this work, and in these cases train-crew controllers are not employed.

Motive-power Controllers must ensure that motive power is used to the best advantage. As with train-crew control, the Motive-power controller must work closely with the section controller in connection with departures from the scheduled working arrangements.

Freight rolling-stock Controllers who work inside a Control office are concerned in meeting distribution requirements quickly and economically. They work in close conjunction with the section controllers.

Assistant controllers may be attached to a particular section or may give general assistance within the Control office. If they are engaged

almost entirely on receiving, recording or transmitting of information, as often happens, they are not really *controllers* at all. Control clerks would appear to be a more suitable name to describe their functions.

MAIN DIVISIONS OF CONTROL WORK

The work of the Control may be divided under a number of headings: (1) Traffic control; (2) Train control; (3) Train-crew control; (4) Motive-power control; (5) Freight rolling-stock control. Each will be dealt with in the following sections.

TRAFFIC CONTROL

Reporting of Traffic on Hand. Traffic control is mainly concerned with the movement of loaded wagons. As effective direction depends on a knowledge of the current situation, it is necessary for Control to be kept informed of the number of wagons on hand at yards, depots, stations, docks, etc., and to know to which points these wagons need to be moved. The reports of the number of wagons on hand and their destinations are usually supplied to the Control at fixed intervals to suit the local circumstances. Traffic on hand at places which do not normally make reports, must be advised specially.

The information supplied at specified intervals should be supplemented by any special information which comes to the knowledge of the reporting points between the fixed times. This information should include advices of exceptional quantities of traffic passing or about to pass, or of surpluses or shortages of traffic for booked services. Particularly urgent traffics for which no previous arrangements have been made should also be reported. The earliest advice should be given from one district to another of traffic information of mutual interest.

Recording of Traffic-stock Information. The information is recorded on stock sheets which are held in the Control office and which show each depot or yard separately. They have sufficient columns to enable all the reports of one day to be inserted on one sheet. A scrutiny of the stock sheets after completion shows how successful the Control has been at moving traffic currently.

Relating the Traffic to the Service

Freight Traffic. Traffic control consists of relating the traffic, which requires to be moved, to the services available to move it. If it is apparent that the prearranged trains are inadequate in a particular direction, the Control function is to augment the booked services. This helps to keep traffic and mobile equipment moving and to provide the reliable service which the customers demand.

It is also necessary to make the most economical use of locomotives by securing the maximum authorized loading of freight trains. If the reports show that there is no traffic for a particular train it may be possible for the Control to cancel it. Before doing so they must take into account the diagrams. It may be necessary for the engine and crew to make the journey without a train in order to be available for a return load. Alternatively, the crew may have to be got back to their home depot within their working day. If traffic is light, some combination of trains travelling in a common direction may be possible, again bearing in mind diagram considerations. In view of the importance of reliable transits, controllers should not cancel trains on account of light loading, unless there are alternative means of getting the traffic to its destination without delay.

However, a Control may sometimes be forced into sacrificing a small number of wagons in favour of a larger number, or less important traffics in favour of more important ones. Additional locomotives and men are needed to work the extra trains in those directions where the booked service is inadequate. Any engines or crews that are unbalanced may be used; so may those who have spare capacity in their diagrams. These are supplemented by engines and men specifically supplied to work according to Control instructions. But the number of these is limited and it may be politic to divert locomotives and men for this purpose from routes for which there is little traffic to routes where there is an excess.

In putting on extra trains, Control must pay regard to the route availability of locomotives, route knowledge of crews, line occupation situation and the possibility of getting a return load from the destination point. The selection of a path which will give a satisfactory service to the traffic without causing delay to other trains, calls for careful judgment. When other districts are involved, the agreement of the appropriate District Control offices or Headquarters Control must be sought. If it is necessary to augment a particular service frequently, because the scheduled programme is inadequate, it would appear that the plan of operation needs adjustment. When the necessary amendments to the plan have been made, this will leave the Control free to deal with genuine day-to-day matters.

Certain traffics are accorded special priorities in transit, and Control keep a special watch on these. Livestock, perishables, shipping, Assured Arrivals (See Chapter 12) and various other traffics may fall into these categories.

In view of the importance of reliable and speedy transits, Traffic Control is often the most important aspect of District Control work.

To improve the standard of service it is necessary for Controls to pay increased attention to transit matters.

Passenger Traffic. On the passenger side, services may require augmenting when the number of people wishing to travel builds up to a high level. Therefore, the Control must be advised of exceptional numbers of passengers for regular or special services. However, the most scope for Traffic Control exists with freight traffic.

TRAIN CONTROL

In Traffic Control the unit is the wagon load. In Train Control the unit is the train load. Every effort should be made to adhere to the W.T.T. plan. The achievement of punctual working is a most important concern of Control. But, when there is divergence from the timings laid down, it is necessary to minimize the reactions and to see that any delay which is unavoidable falls on those trains which can bear it best.

Reporting of Trains

The Control must be kept informed of the current situation. Selected trains, which usually include all freight trains, are reported to the Control from selected points. In some districts it may be desirable for all trains to be reported, but with a properly prepared background, a good picture may be obtained with comparatively few reports. In most places it is necessary for the running of trains which are behind schedule to be advised to the Control. Also it is usual to require any late starts and delays, including signal checks and time lost by motive-power units to be reported from the point at which they occur, with an explanation of the cause if this is available. The section controller may assume that trains, which are not required to be reported unless they are delayed or late, are running punctually in the absence of such reports. Stations, yards and depots may be required to report arrival and departure times, signal-boxes to report passing times.

Recording Train Movements

Various methods are employed in the recording of train movements, such as train cards, train sheets and so on.

Train cards. The section controller is supplied with a card for each train, on which is shown the title or number of the train and its scheduled timings. As the reports come in he inserts the actual timings alongside those scheduled. If there is any disparity between them which cannot be explained by the reports already received, the controller tries to establish the reason. A single card permits the running of the train on each day of one week to be shown. The cause of each delay should be recorded on the card. Any delays which result from the same cause on more than one day are a fruitful source for investigation. Enquiries often

reveal some fault in the plan or in its execution which needs putting right. Train cards also bear certain details relative to the locomotive and crew working the train. Cards for freight trains often show some details of the loading of the trains, with information regarding traffics which require special priorities. The supplementary information shown makes the cards useful in Traffic Control, Engine Control and Trainmen's Control.

Train Sheets. On a train card may be recorded the performance of one train throughout a whole week. A train sheet permits the performance of a number of trains on one day to be set down side by side. This is particularly useful where the reaction of one train on another is of primary importance. Sheets are often used for the recording of suburban passenger train services which fall into this category. The scheduled times are normally printed on the sheet and a space is left for the insertion of actual times. Separate sheets are normally used for the Up and Down lines. Explanations of delays should be shown, and train sheets may provide for other information similar to that mentioned under *train cards* to be shown as well.

Geographical boards are sometimes used in conjunction with train cards to indicate the positions of freight trains in the District. The boards are erected vertically, facing into the main body of the Control office, and bear a diagrammatic representation of the Control district. All lines, sidings, yards, signal-boxes, stations and so on are shown.

Pegs which carry tickets are used in conjunction with the board. Each peg represents a freight train and as the reports come in indicating the location of the train, the peg is moved along and inserted at the appropriate point. Therefore a glance at the board shows the approximate location of all freight trains which are being reported to the Control. This gives a good indication of the line-occupation situation. Boards show the situation of the trains in relation to each other, a thing which the train cards cannot do. Apart from the value of the board to the Section Controller, it gives an indication of the operating situation to the Deputy Chief Controller and to others who are concerned with the running of these trains. The tickets identify the train concerned and may also bear information of loading, details of the engine and of the train crew. Both pegs and tickets may be in different colours according to the class of train which is represented, and to distinguish Up and Down trains. Train loads of traffic or of empty wagons which have been placed into temporary storage are also indicated on the board to provide a visual reminder to all concerned.

Control Graphs. In control offices where there is a good deal of train regulation to be done, the graphing method offers some advantages.

Control graphs are similar to the graphs used for timing purposes, and which were described in Chapter 9. Whereas timing graphs are used for plotting the scheduled paths, on the Control graphs the actual times are plotted as the reports come in from reporting points. The relationships between the trains are clearly shown and the graph is useful in indicating to the section controller when some intervention on his part is required. It also helps him to decide which is the best action to take.

The paths of certain trains which are not reported (except when delayed or late) may be printed on the graph in their scheduled timings. The section controller is thereby reminded that these trains must be taken into account when controlling train movements. If incoming reports indicate that trains printed on the graph are running out of schedule, suitable endorsements must be made. Different classes of trains may be plotted by the controller in different colours according to the type of train and the line on which it is running. This is useful in attracting attention to light-engine mileage. Train numbers or similar devices are used to identify the particular trains. Additional information regarding the locomotive and crew or the load is inserted in compartments provided for this purpose on the edges of the graph.

Advantages of Graphs over Train Cards and Geographical Boards

Completed control graphs show where there has been unused line capacity. This may suggest retiming of trains from a congested period, or alternatively, consideration may be given to reducing the hours of opening of certain signal-boxes. They also reveal where errors in regulation have been made. Signal delays are indicated by a red horizontal line and can be easily picked out. The graph illustrates the cause of delay in those cases where it is due to the reaction of other trains. A study of the circumstances may show that an alternative method of working would have produced better results, and the lesson learned should be applied in future cases of this kind.

It will be appreciated, therefore, that the graph fulfils a similar function to that performed by the geographical board and train cards together. But in addition it provides a permanent record of the trains set out in relation to each other. This facilitates supervision of train regulation. Its compilation is easier than the card and board method. On the receipt of a report, say a passing time from a signal-box, the controller—using a graph—only needs to draw one line; i.e. a line from the last reporting point to the present reporting point at the times indicated. With card and board, the controller must write up to four figures and then move the peg along the board to the latest reporting point.

Because the controller—using cards and a geographical board—is required to perform two functions on receipt of reports, there is a

danger that one of them may be omitted, particularly at a busy time. The geographical board is the most likely to be neglected in these circumstances, and may not always show the current situation. Explanations of some delays which require writing out at some length on the cards may be apparent from the graph without any writing on the controller's part. The importance of reducing the amount of time controllers spend on recording will be emphasized later. The main superiority of cards is that they show six days working of a train whereas the graph only shows one day.

Passing Information between Sections

As trains pass from one section to another it is necessary to pass details of them from one section controller to another. Where train cards are used, the card itself is passed over. If geographical boards are used the peg and ticket must also be transferred from one section to another. In control offices where graphs are used a special ticket conveying the information is usually prepared and handed over from one section to the next. The transfer of train information and the necessity for consultation between contiguous sections makes it desirable that the desks of section controllers should be properly arranged in relation to each other.

Where a section borders on a section in another District similar consultation and exchange of information is required. In this case the telephone, teleprinter, or telegraph, is employed.

Controlling Train Movements

After the Control have received the information of train running and have recorded it, then it is available for the benefit of train working. In most districts train regulation is primarily the responsibility of the signalmen. It is necessary that this responsibility should be delegated to the signalmen where it is practicable to do so. Signalmen ultimately control train movements by the operation of their signals, therefore it is preferable that they should regulate on their own initiative rather than be subjected to frequent direction from Control. There is also the consideration that the passing of messages between the two takes time. Time is an important factor in regulation. The time taken in making contact and giving an instruction could mean the loss of an opportunity to run a train, thus causing unnecessary delay. However, there are times when the signalmen may ask for assistance from the Control. Although the signalman is supplied directly with information to enable him to regulate, the Control is aware of the situation over a much wider field than he is.

In certain circumstances it is necessary for Control to give definite instructions to signalmen in regard to train regulation, by virtue of

their wider knowledge of the situation. For example, signalmen must regulate according to the priority classification (head codes) of the trains concerned. But there are occasions when a train of low classification needs priority over one of higher classification.

It is desirable that in cases of time lost in running which is apparently due to motive-power causes, the Control should satisfy themselves in regard to the details. If there is a loss of time which cannot readily be explained, it is wrong to assume that it is necessarily due to motive-power shortcomings. It may have been caused by signal delays which the signalman concerned has failed to report. The motive-power depot at which the enginemen sign off should be contacted in order that the men may be questioned before leaving duty.

Adjustments in Emergencies

A good district control organization is particularly useful after mishaps or when other circumstances demand substantial changes to the scheduled programmes of trains. After consultation with station masters, yard masters and other staff on the ground, diversions, cancellations and special services can be arranged, based on a knowledge of the situation as a whole. The avoidance of congestion and overloading of line capacity is imperative. Headquarters Control can be helpful in regard to adjustments required to inter-district trains. After normal working has been restored, traffic is likely to be in arrears and Control should make every effort to move it quickly to its destination. Special care is required to ensure that any loads of freight traffic which have been put into temporary storage to ease line occupation are not left there any longer than is necessary.

TRAIN-CREW CONTROL

One of the main reasons for the introduction of Control offices was to reduce the working of excessive hours by train crews. This had reached serious proportions prior to the institution of the first Control in 1909, but the new organization which quickly spread over a wide area was successful in curbing it. Because of increased and better planning of the work of train crews and due to a general improvement in the fluidity of freight train working, it is now only a subsidiary function in most Control offices. Considerable intervention by Control in train-crew working should normally be unnecessary as far as time-table trains are concerned. If it is required regularly, the plan of operation may be at fault and should be examined.

However, it is the responsibility of Control to see that enginemen and guards do not incur excessive hours; e.g., when trains are running late. This may be avoided by using the available staff to the best

advantage. Arrangements may be made to relieve trainmen who have completed a full shift's work by others who have spare time within their roster, or by those whose train working is unbalanced and who are diagrammed to travel as passengers. Alternatively, the men provided to work to the instructions of Control (Control order men) may be used. These men, and those with spare time in their rosters, are used to work extra trains arranged in connection with Traffic Control. The men who become spare on account of the cancellation of any part of their rostered working are also available for use. Efficient control of train crews keeps train-crew costs to a minimum by reducing overtime working and by operating with the least number of Control order sets. A record of the use made of these men should be kept and frequently examined to permit reductions to be made in the number employed, at the earliest opportunity. A District Control is equally concerned with train crews who are stationed at depots within that district and with men working in from other districts.

MOTIVE POWER CONTROL

The best use is made of motive power when the motive-power depots and Control adhere to efficient diagrams to the maximum extent. Motive-power depots must not be permitted to allocate an engine to a train, unless it belongs to the depot scheduled to work that train, without Control permission. Some requirements beyond those diagrammed are involved when extra trains are run, and Control must make the best use of unbalanced workings. Cancellations of booked services also necessitate diagram adjustments.

Liaison between Control and the Motive-power Depots

Motive-power depots are required to give immediate advice to Control of anticipated unavoidable departures from diagrammed engine workings. For example, because of a mechanical failure they may be unable to supply the class of locomotive diagrammed, or the locomotive may be late from the depot, or possibly they may be unable to supply a locomotive at all for a particular train. Control may then take steps to mitigate the consequences. At specified intervals the motive-power depots must advise the Control of the power position which includes information of: (i) engines away from the depot without a prearranged return working; (ii) other depots' engines on hand which are unbalanced; (iii) other depots' engines on hand under repair. The motive-power controller must ensure that a proper balance of power is maintained between the various depots.

Control should give early advice to the motive-power depot when a special engine is required or a booked engine is cancelled. Control

must also advise them when an engine is likely to arrive in the depot late, so that special arrangements can be made to provide an engine promptly for the next part of the diagram. Control must ensure that engines are released promptly after completion of their work, and are returned to the depot without delay.

Making the best use of Unbalanced Engines. Unbalanced engines must be supervised by the Control. Only the minimum amount of light mileage or unrequired double-heading should be incurred. Ways of employing them productively should be sought, but it is necessary also to ensure that they are returned to their home depots quickly, or there is a danger that the depot will be unable to meet its commitments.

The nature of the traffic may create a lack of balance in engine working. Trains leaving a district may convey a majority of loaded wagons and the incoming trains mainly empties. Therefore, incoming engines will be able to convey larger loads and there will be a tendency for engines to become unbalanced outside the district. To reduce line occupation it may be desirable for some coupling together of light engines to take place, or extra engines to be coupled to trains. The use of engines belonging to one district working in another, may be decided at the discretion of the Headquarters Control. The greater the adherence to diagrams the less is motive-power control required. It may therefore, be possible to dispense with staff employed wholly on it, and to combine it with the train-crew controller's duties.

FREIGHT ROLLING-STOCK CONTROL

In Chapter 3 the distribution of freight rolling stock was discussed in some detail. Within the Control office the same kind of considerations apply to the movement of empty wagons as to the movement of loaded ones. These were set out under *Traffic Control.* The movement of empties is often of equal importance with that of loaded wagons.

Distribution of Freight-train Brake Vans. The diagramming of brake vans to work particular trains is only done on a small scale. It may be that better utilization would result if this were extended. The more usual method employed is a distribution system based on a planned allocation for each yard or station where brake vans are required for freight train working. The allocation represents the number of vans required at a particular time each day to cover the working for the next 24 hours, after an allowance has been made for vans expected to arrive. A small reserve to cover late running may be justified.

Shortages or excesses must be adjusted between yards by Control and between districts by Headquarters Control. It is imperative that disposal instructions should be fully and promptly carried out.

REDUCING RECORDING WORK

As Control offices are often open continuously and as they have a comprehensive telecommunications system, they provide a convenient channel for collecting information. In consequence, there is sometimes a tendency for the Control organization to degenerate into a recording agency. This is undesirable on two main counts: (*a*) Information required for purposes other than control work may occupy the communications system at a time when it is required for important Control information. (*b*) If controllers are required to record this information either they are distracted from doing their legitimate work, which must suffer, or more controllers are employed than is necessary.

It is desirable to make periodical checks to see if any of the reports being made to the Control can be dispensed with. The basic test to apply is whether the information is necessary to enable the Control to do its job. If it is not, but the information is required for other purposes, it should be ascertained if any satisfactory alternative means can be devised for passing the information through. If the information is not serving a useful purpose it is wasting the time of both the controller and the person who is advising it to the Control.

At the beginning of this chapter it was stated that Control should direct operations. It was also said that it should justify its existence by the results it achieves. Controllers must be given time to think. If they are relentlessly engaged on recording they cannot direct efficiently. If Control becomes primarily a recording agency instead of a directing agency, the chances are that it does not justify its existence. Much cheaper ways of recording information are available.

SUMMARY

1. *Control should pay its way.*
2. *Control's first duty is to stick to the plan of operation.*
3. *If the plan breaks down, it should be restored as quickly as possible.*
4. *Frequent repetitive alterations to the plan suggest that the plan needs adjustment.*
5. *Control must win the confidence and co-operation of the outside staff.*
6. *The best organization unifies responsibility for making the plan and changing the plan.*
7. *Co-ordination between different controls and different controllers is essential.*
8. *Efficient traffic control contributes to speedy and reliable transits.*
9. *It also economizes in working costs.*
10. *Train regulation is usually best left to the signalmen.*
11. *The function of control is controlling, not recording.*

CHAPTER 11

Freight-train Services

THE receipts from freight traffic comprise a much larger proportion of railway revenue than do passenger receipts. It would be true to say of the larger part of the railway that freight traffic is the basis of the economy, and the operator must provide the quality of service which will permit him to obtain the greatest share of the available traffic. At the same time, he must operate at the lowest cost in order that the rates to be charged may be kept down to competitive levels, and that he may still acquire a satisfactory net revenue. Different types of traffic present different problems and it is advisable to examine the more important types in some detail.

COAL TRAFFIC

The largest single commodity carried by rail is coal. In spite of short average hauls, the receipts for its conveyance are greater than those from any other traffic. Therefore a decline in the amount of coal traffic carried by rail has a serious effect on the economy of the organization. Much of the decline which has taken place has been beyond the power of the railway to influence as it is largely attributable to the change-over from solid fuel to other forms of fuel. But where coal is failing to withstand competition from other sources of power mainly on account of cost, the transport charges may be of considerable influence. The delivered price determines the market for coal in many instances. In consequence the operator must be constantly re-examining his working arrangements to see if he can carry coal more cheaply. If he can, and if this is passed on to the customer, it may make the difference between coal being used and not being used—between the traffic continuing to pass and ceasing to pass. When coal is replaced by other forms of power, the traffic for conveyance by transport organizations dwindles. For example, one ton of oil can produce far more heat equivalent than a ton of coal, and one ton of uranium is equal to three million tons of coal. It is, therefore, in the interest of the transport operator to help in keeping down the delivered price of coal.

The railway is in competition with other forms of transport, particularly road and coastwise shipping, for the traffic available. Statutory protection is given to coastwise shipping, but the respective proportions

carried by road and rail depend to a large degree on the efficiency of operation of these two forms of transport. The construction of road vehicles of greater capacity and with improved mechanical efficiency has assisted the road operator to compete more effectively.

Almost all coal, by rail, originates in private sidings. Most of it also terminates in the private sidings of power stations, steel works, factories, etc. The remainder, which requires transhipment at a rail terminal, is particularly vulnerable to road competition. This applies especially to traffic for consignees able to accept full lorry loads.

The advantage of rail over road is more pronounced over longer distances and particularly with traffic in full train loads for power stations, coal concentration depots, etc. However, as wagons are normally loaded closer to their capacity when conveying coal traffic than when carrying ordinary merchandise traffic, rail haulage can often still compete over quite short distances. Rail-movement costs arise from (1) provision of the wagon; (2) haulage; (3) shunting. An examination of these so far as coal traffic is concerned is of interest.

Wagon Costs. A coal wagon is of simple construction, which is reflected in comparatively small annual costs per wagon. But utilization of coal wagons tends to be poor on account of:

(*a*) Slow transits of loaded and empty wagons.

(*b*) A high ratio of empty running. As the wagons are normally confined to coal traffic, many of them have empty journeys from the coal consuming areas to coal producing areas after each loaded trip.

(*c*) Peaks result in wagons standing idle at off peak periods.

(*d*) Long turn rounds. At the colliery this may be due to different grades of coal being loaded at different points, and the necessity to have a reservoir of wagons at each point. Alternatively, it may be due to excessive ordering of empties by the collieries or to wagons being loaded, and then being detained under load, until orders are received from customers. The operator must keep a careful watch on these matters, especially at times of peak demand.

At destination, detention of wagons is an even greater problem. See Chapter 3, pages 50-52. The best contribution that train-working arrangements can make to the reduction of wagon costs is an acceleration of transits of loaded and empty coal wagons. Any ideas that there is no urgency in coal transportation should be dispelled.

Haulage Costs. The principal items are as follows. (*a*) Providing and maintaining the locomotive. (*b*) Stabling, servicing, preparing and disposing of the locomotive. (*c*) Enginemen's wages. (*d*) Fuel, water and lubricants. (*e*) Guards' wages. (*f*) Provision of guard's brake.

Apart from item (*d*) these vary according to the degree of utilization

achieved, to give a certain cost per train-mile. Good utilization is particularly difficult to achieve as the average length of haul of coal traffic is very short (about 50 miles) and therefore it is difficult to keep equipment and staff moving. But the train-mile is not the end of the story. The cost per wagon-mile depends on the number of wagons on the train. If a train conveys 40 wagons the cost per wagon is only half as much as if it conveys 20. Therefore, the train-working arrangements should be directed to making full use of locomotive capacity.

Shunting Costs. These arise at the sending point, at destination and also intermediately if wagons enter marshalling yards. The train-working arrangements should avoid entry into marshalling yards whenever possible.

The contribution which freight-train working arrangements can make to reducing costs may be summarized thus:

(1) Wagon costs—speed up transits.
(2) Haulage costs—ensure good train loads and economical working.
(3) Shunting costs—avoid marshalling yards. Where used, employ them to the greatest advantage.

Items (2) and (3) are often in confliction as it may be necessary to enter yards in order to get good train loads and some compromise is necessary. But items (1) and (3) are complementary, as avoiding marshalling yards is one of the best ways of speeding up transits. Sometimes this may justify more emphasis being laid on (3) rather than on (2). This is discussed in more detail later under the heading *Large Train Loads or Small?* There is one way which requires no compromise between good train loads and entry into marshalling yards. This is called Nominated Loading.

Nominated loading involves the colliery handing over traffic in full train loads or block loads from one colliery, or adjacent collieries, for a single destination on nominated days. This gives the following operating advantages: (1) better transits; (2) better wagon user; (3) reduction of work in marshalling yards; if employed on a sufficient scale it could permit certain yards to be closed; (4) efficient use of engine power and train crews. The economies in working full train loads are so great that substantial reductions in rate are made possible. These should more than compensate the customers for the inconvenience, if any, involved in despatching and accepting coal by the train load. Nominated loading may be applied to any suitable traffic but the greatest scope for its application is with coal. Other traffics for which it is used include iron ore, oil and so on.

Fortunately the tendency is for block loading to become easier to achieve owing to the concentration of coal production at the larger

collieries and the closing of smaller collieries. Some of the main consumers likewise are concentrating their production at large centres; e.g., electricity generating stations, gas works, iron and steel producers etc. These concentrations at the producing and consuming ends of coal business enable more full train loads to be worked direct from a colliery to a private siding without any intermediate shunting. Similar advantages may be derived by returning the empty wagons in block train loads to the colliery, preferably by the locomotive and crew who worked the loaded wagons in.

Benefits of Coal-concentration Schemes to Train Working

Sending coal in full train loads from colliery to destination is only possible where the consignee is a considerable consumer or where a number of consumers are concentrated at one point. Reference has been made in Chapter 7 to the desirability of coal for household coal merchants and small industrial consumers being concentrated instead of being dispersed at wayside stations. The necessity to distribute wagons of coal to the wayside stations involves their entering marshalling yards. This causes delay in transit, which is increased where the distributing service runs only once or twice a day. Similar delay is incurred in collecting the wagons after they have been emptied. The train services which take the wagons to and from the wayside stations are frequently lightly loaded and therefore the haulage costs are high for this portion of the journey. In addition, if the station is on a branch line the track and signalling costs are likely to be considerable.

If a coal merchant is reluctant to change his scene of operations, it may be worth while for the railway to deliver coal by road from the concentration point, in order to achieve the operating benefits associated with concentration. Care must be taken that increased road delivery costs do not absorb all the economies made on rail.

Irregularity of Coal Forwardings. In Chapter 10 it was explained that fluctuations in the amount of traffic forwarded often necessitated adjustments being made to the plan of operation. These variations in traffic level may result in uneconomic working because:

(*a*) Reserves of motive power and men have to be available to deal with extra surges of traffic in a particular direction.

(*b*) Motive power and train crews diagrammed to work trains may be unused because no traffic is available for their scheduled workings.

The variations in coal forwardings are often more pronounced than with other traffics. A colliery may turn out traffic mainly for destinations in a northerly direction on Monday. On Tuesday it might be coal mainly for a destination to the South, and on Wednesday for destinations to the North, South, East or West. The pattern the

following week may well be quite different. Where these kind of variations occur, without adequate prior notice, the alterations to the plan of operation are likely to be numerous, and the disadvantages mentioned above are more pronounced.

Yet, apart from seasonal variations, the production and consumption of coal is reasonably consistent. One exception to this is coal for shipment. This demands an adequate flow of coal into the port when ships are loading, but little is required between ships. Even where it is possible to plan a regular programme of ships, this may be upset by weather conditions. So far as coal for inland use is concerned the operator would gain a great deal if the consistency in demand could be translated to consistency in forwardings week by week in order that services could be prearranged. This is another reason why nominated loadings are desirable. Where nominated loadings are not possible, there would appear to be an advantage in granting rate concessions for traffic passing in a regular pattern which would avoid daily dislocation of the scheduled arrangements. To cater for increased forwardings of a repetitive nature it is advisable for *Q* paths (see Chapter 9, page 167) to be provided in the W.T.T.

Train Services for Coal Traffic. Summarizing the position for coal traffic, it may be stated that:

(1) To improve the service to the customer and to reduce the cost of providing wagons and shunting, faster transits should be given by through-working of train loads from colliery to destination. This can be best achieved by: (*a*) nominated loading; (*b*) concentration of coal traffic at fewer rail terminals.

(2) These steps will also enable haulage costs to be reduced by giving better train loadings and by eliminating lightly loaded trains.

(3) A more regular pattern of forwardings should be sought which will reduce expensive alterations to the plan of operation. Where variations in forwardings cannot be prevented, the maximum notice of the details of each day's forwardings should be elicited from the colliery to permit a measure of forward planning to be introduced.

RAW MATERIALS (EXCEPT COAL) FOR THE IRON AND STEEL INDUSTRY

This traffic (mainly iron ore and limestone) passes almost entirely from private siding to private siding in full wagon loads and often in full train loads. From this point of view it is an ideal traffic for rail conveyance and in consequence rail can be more efficient than road even over very short distances. The customer is not so demanding regarding transit times as with many other traffics and a continuous

supply is his main consideration. The urgency in moving it arises mainly from the need to keep down operating costs.

The two main drawbacks with this traffic are: (*a*) Empty wagon haulage equivalent to the loaded wagon haulage is normally involved after each loaded trip because of the special design of the wagons. (*b*) Ships bringing imported traffic tend to arrive irregularly and as they must be discharged quickly there is much variation in the demand for wagons. This also upsets the pattern of the train service and calls for modifications to the scheduled programme.

FINISHED AND SEMI-FINISHED PRODUCTS OF THE IRON AND STEEL INDUSTRY

This traffic originates in private sidings and terminates either in private sidings or at terminals. It is normally wagon-load traffic but is not often despatched in through train loads from the steel works to destination. As transhipping from rail vehicle to road vehicle may be involved at a terminal and because it is not normally train load traffic, it is susceptible to road competition.

Some of it is conveyed in ordinary goods wagons but the remainder uses the steel-carrying wagons which were described in Chapter 3. Quick transits are vital to retain the traffic to rail and to reduce wagon-provision costs. The traffic which is conveyed on steel-carrying wagons presents special transit problems, especially when it consists of exceptionally long or heavy articles overhanging the ends of the wagons or occupying more than one wagon. In these cases restrictions on the speed of movement are often imposed on account of unequal distribution of weight on the wagon axles and journals, and the high centre of gravity of the wagon and its load. The effect of these restrictions has been that where certain freight trains have been scheduled to run in accelerated timings, iron and steel traffic, formerly conveyed by these trains, has had to be transferred to slower services. As more fast services are introduced the residue of slower trains becomes less. The fewer services available for this traffic often involve additional entries into marshalling yards and long waits for the next slow train. The effect of faster trains on this traffic has been slower transits.

It is necessary, therefore, to consider whether existing restrictions on these wagons can be relaxed without detriment to safety. Secondly, all new steel-carrying wagons should be constructed to specifications which will permit them to run at express speeds. Thirdly, wagons should be used which can completely contain the loads, thus eliminating overhang and loading on to more than one wagon. This necessitates more use being made of bogie wagons and the gradual elimination of

the short-wheel-base single bolster wagons. Fourthly, it is necessary to improve methods of securing loads so as to permit safe travel of loaded wagons at high speeds. Finally, it should be made clear to all concerned which class of train may be permitted to convey each type of steel-carrying wagon either loaded or empty.

PETROL AND OIL

This traffic sometimes presents the same problems as steel traffic as it may be excluded from the faster freight trains (see Chapter 3, page 44). Until the difficulties of those tank wagons, which are unsuitable for fast running, have been solved, it is important that special arrangements should be made to give speedy, reliable transits. This may take the form of moving the tank wagons on trains provided exclusively for this traffic.

The movement of petrol and oil is mainly from private siding to private siding in privately owned vehicles. In the absence of terminal and wagon costs it is a cheap operation especially in full or part train loads. Traffic is often available in these quantities from the refineries, which are mainly on coastal sites, to the inland distribution depots and to large industrial consumers. A growing competitive danger where really large flows of traffic are concerned is the pipe-line. The railway operator must be particularly careful to give a good service at a low rate in these cases, or the most profitable traffic flows are likely to be lost for all time.

OTHER BULK TRAFFICS

These include chemicals, some agricultural produce and building materials of all kinds such as timber, bricks, sand, cement, etc. A good deal originates from private sidings but finishes its rail journey at freight terminals; some is from one terminal to another. Where transfer between road and rail vehicles is involved at a terminal, the duration of the transit is extended and terminal costs have to be added.

GENERAL MERCHANDISE (WAGON LOADS)

Merchandise traffic normally brings in higher receipts per ton-mile than coal and other bulk traffics. In addition, the average length of journey is greater, and the operating advantages which derive from traffic over longer distances apply (see Chapter 1, page 14). On the other hand, the average load per wagon is much lower and the railway may be required to perform extra services; e.g., loading, unloading, cartage etc. However, a higher standard of service is demanded (often overnight delivery) and therefore if more of this remunerative traffic

is to be acquired to rail, the operator must not fail to meet these standards. This is so vital a matter that Chapter 12 will be devoted to it.

Most of the transport of general merchandise in vehicle-load quantities in Great Britain is done by road. It is the job of the railway operator to offer a high standard of service at the lowest cost in order that more of it may be secured to rail.

Private Sidings with little Traffic. Of the general merchandise which is carried by rail, substantially the larger part originates in private sidings and rather more than half of it also terminates in private sidings. This has the advantage of eliminating transhipment between road and rail vehicles, but it also has its drawbacks. These apply more with general merchandise than with the bulk traffics previously mentioned. With coal, iron ore, steel, petroleum products etc., the traffic often comes out of or goes into private sidings in substantial quantities. This sometimes applies with general merchandise traffic, but some is dealt with at small sidings with little traffic. The amount of shunting required to sort the traffic to and from many small private sidings is a considerable factor. The trip trains or pick-up trains which service them are likely to be lightly loaded trains and the haulage costs per wagon are correspondingly large. Those little-used sidings which are situated on branch lines may be served by trains which require to bear heavy track and signalling costs. They often present an obstacle to the closure of the line. Those on main lines may present line-occupation problems.

It is necessary to weigh the advantages of the absence of a road/rail transfer against the disadvantages of serving private sidings which have little traffic. In certain cases it may be better to withdraw the rail service to and from the siding and to transport the traffic by road between the traders' premises and the nearest freight terminal.

Building of new Private Sidings. The traffic of firms which forward or receive a considerable volume of freight but have no rail siding at their premises, may be secured better and handled more cheaply if a siding is constructed. The relative values of the items mentioned earlier must be assessed to ascertain if a siding is desirable. In former days the expense of construction and maintenance of the siding was usually borne by the trader. Now there may be every reason why the railway should meet these costs, providing it is a good commercial prospect to do so.

GENERAL MERCHANDISE (SUNDRIES)

This traffic passes only between the main terminals. The number of wagons remains fairly constant from day to day, and they should all

be suitable for express freight conveyance. As far as possible the services should run between terminals, but some entry into yards may be unavoidable if the trains are to convey reasonable loads.

TRAIN-SERVICE STRUCTURE

The aim should be a fully planned and timetabled national network of trunk trains between private sidings or terminals, thus reducing entry into marshalling yards to a minimum. Where the use of marshalling yards is required the trunk trains should interconnect with feeder services to reduce the time wagons spend in the yards. Certain trunk trains should exchange marshalled sections at intermediate yards. This enables good loads to be conveyed without subjecting all the wagons on the trains to the disadvantages of the shunting process, which were described in Chapter 8.

Although, for convenience, separate consideration has been given to different traffics under previous headings, it should be appreciated that they often share common trains. For example, many mineral wagons are conveyed for some part of their journey by a train which mainly consists of other freight traffic.

In Chapter 2 it was shown that the best use is made of line capacity when trains travel at the same speeds. Ideally, where freight and passenger trains use a common track they should run at equal speeds to avoid the need for overtaking. Unfortunately it is not safe for four-wheeled vehicles of less than 15 feet wheelbase to be conveyed on trains exceeding 60 m.p.h. As large numbers of wagons are in this category it is necessary for trains conveying them to be restricted to 60 m.p.h. It is not feasible that passenger trains should be so restricted, and some difference in speeds between freight and passenger trains is unavoidable.

From the line-capacity point of view it would be desirable at least for all freight trains to run at equal speeds. This is not possible because of the more severe speed restrictions imposed on certain loads and on certain types of wagon. Differences in freight-train speeds are also brought about by the use of wagons not fitted with the vacuum brake. If braking power is available only on a proportion of the wagons or only on the locomotive, the speed may have to be limited to permit the train to stop within the appropriate braking distances.

Certain feeder services run as unfitted trains because the time which would be saved in running, if the train were accorded a higher classification, would be more than offset by the time taken in screwing up couplings and engaging vacuum pipes at the stations where traffic is attached.

These processes have to be reversed when the train is split up. There is a great need for automatic couplings which would obviate this difficulty, and would generally speed up journey times. To run unfitted trains may be more expensive than to run fitted ones, as the single-manning agreements (see Chapter 9, page 164) provide for double-manning of motive-power units on unfitted trains.

Sometimes the maximum speeds at which trains may be run is governed by the speed potential of the motive power employed. This particularly affects freight trains worked by trip engines, which are primarily designed for shunting work. The pick-up train which calls at wayside stations and sidings may have to stop so frequently that there is no opportunity to reach high speeds. As it may be required to enter sidings with curvature of small radii, it may be necessary for the train to be worked by a small locomotive which is incapable of fast running. Train-working arrangements should provide for the elimination of this type of train when possible. Those freight trains hauled by steam locomotives which were designed to pull heavy trains at low speeds, must also travel at slower speeds.

In accordance with the first principle of operation, trains should make the least number of intermediate stops. When trains are not fully loaded between two main centres there is a temptation to use them for conveying odd wagons to intermediate destinations. Care must be taken that this is not done to such an extent that the transits of the main part of the train load suffer. As with passenger trains, freight trains may be scheduled to stop for traffic or motive-power purposes and for train-crew relief. In addition, unless the wagons are all fitted with roller bearings in the axleboxes, they have to be examined at specified mileage intervals. This may necessitate special train stops.

Classification of Freight Services

Trains are classified according to the speeds at which they are scheduled and the conditions (e.g., whether fully fitted with vacuum brake, partially fitted or unfitted) under which they run. The classification is shown by a code letter at the head of each train column in the timetable. Train locomotives may exhibit headlamps or discs in various positions which indicate the class of the train. These head codes show how the train should be signalled and the precedence it should be accorded. Head codes may also be used for routing purposes.

The method of indicating train classification by headlamps is gradually being replaced by a four-position train classification, destination and identification system. The locomotives or multiple-units exhibit the train code number in the indicator boxes above the driver's cab. The basis of the code is as follows:

First position.

A number 0 to 9 indicating the classification of the train.

Second position.

Letters of the alphabet indicate the destination area of the train.

Third and fourth positions.

A two-figure number which is the identification of the particular train and which is shown in the W.T.T. or the Special Train Notice.

These codes are transmitted between signal-boxes on the train-describing apparatus (see Chapter 2, page 33).

The aim should be to reduce the number of classifications to simplify operations. This should be done by lifting the slower and lower classified trains up to higher speeds as soon as the obstacles which restricted acceleration have been overcome.

Freight-train Incentive Bonus Schemes. In order to speed the movement of freight trains and to reduce the time taken in shunting, when trains stop to attach or detach, an incentive bonus is desirable for train crews and also for the shunters and signalmen concerned. These schemes are particularly valuable with pick-up and other local trains which are concerned with tripping traffic to and from private sidings, and where work is performed with little supervision. By relating the earnings under the bonus scheme to the time taken to do the work, fewer locomotives and men are required and line capacity is made available for other services. Some of the money saved is paid in bonuses, the remainder being available for putting back into the industry.

Large Train Loads or Small?

On the one hand the importance of fast speeds for freight trains has been emphasized; on the other, the desirability of permitting locomotives to pull the maximum loads has been stressed. These two requirements are obviously in confliction. A locomotive can take a large load slowly or a smaller one more quickly. It is necessary to resolve which is more important and to assess which is the most efficient arrangement for each line.

On a line used solely for freight traffic it is possible to assess precisely what loading gives the cheapest haulage costs. To move a specified amount of traffic, more trains conveying small loads would be needed than if larger loads were taken. But to counteract this, if the smaller trains went faster, the locomotives and crew could possibly work more trains in a given period.

Frequently, freight trains have to share the tracks with passenger trains. In these cases, fast freight trains with smaller loads would be advantageous to increase line capacity. Opportunities would occur for fast trains to run where slower ones could not run and by-passing

could be reduced, thus bringing down the costs of operation. In addition, working with smaller, fast freight trains has other advantages.

(1) Smaller train loads makes it easier to justify through trains between one point and another thus reducing the entry of wagons into intermediate marshalling yards.

(2) Smaller train loads may permit trains to be run at more frequent intervals thus giving a better service.

Faster and more frequent trains, which by-pass intermediate yards, mean a better standard of service and a reduction in wagon and shunting costs. But the operator must not move too far in this direction or line-occupation problems will be created by the running of too many trains, and train-working costs will increase in consequence.

CALCULATION OF FREIGHT-TRAIN LOADS

When the best relationship between speed and load has been established, the maximum permitted loads must be defined so that trains may maintain their scheduled timings. The loads of trains are based on the number of wagons, but in order that regard may be paid to the variation in carrying capacity and the differences in weight of the various commodities, it is necessary to devise a formula to determine the equivalence in load value.

It is necessary to establish a basic unit in which maximum loads can be expressed and then to equate other wagons to that unit according to their capacity and the weight group of the contents. For example, the basic unit could be a 13-ton-capacity wagon conveying light loads, say up to six tons. All wagons with greater capacities and heavier loads, also empty wagons, to be equated to this by a predetermined formula. It is important that the guard or other person responsible for calculating the load should be able to identify immediately the category into which each wagon should be placed. A suitable endorsement on the wagon label suffices; e.g. *Light*, *Medium*, *Heavy*, *Empty*.

The system described is not as accurate as precise load calculation, but it is simpler. Simplicity is of supreme importance bearing in mind the conditions in which the calculations have to be made and the time available for making them. A ready reckoner should be supplied to all staff concerned to facilitate calculations.

The absence of more precise load calculations is not as serious as one might imagine at first thought. The ability of a locomotive to haul a particular load at certain speeds varies according to the weather conditions. The maximum defined loads must make some allowance for this, otherwise a wet rail or a heavy side wind would result in bad time-keeping, and in consequence bad service to the customers.

PUNCTUALITY

From the point of view of operating costs the penalties of unpunctuality are greater with freight than with passenger trains. Because freight trains in the main are accorded lower priorities (*a*) late running of passenger trains causes delay to freight trains, and (*b*) freight trains which lose their scheduled paths suffer further delay when they have to be side-tracked by passenger trains. Many of the points in Chapter 14 on how to maintain punctual working of passenger trains apply to freight trains; e.g., having a sound plan; sticking to the plan; necessity for a punctual start; importance of clear signals; desirability of confronting drivers at the first opportunity with details of time lost. With freight trains particular attention must be given to:

(i) Use of the correct rolling stock and motive power to enable the booked classification of trains to be maintained.

(ii) The thorough examination of wagons before loading, including the pre-testing of vacuum brakes.

(iii) Loading wagons in a suitable order to minimize shunting.

(iv) The working at intermediate stops. (*a*) Marshalling of wagons on trains to facilitate detaching in the shortest time. (*b*) Marshalling of wagons to be attached at the calling point in train order, before the arrival of the train and placing them in an easily accessible position.

(v) Ensuring that the lower classified trains are not held unnecessarily. Undue emphasis on the punctuality of the more important trains may result in less important ones being detained when in fact there was an opportunity for them to run without causing delay to other services.

(vi) Increasing the classification as opportunity offers. The faster freight trains tend to maintain their schedules better than the slower ones because they are by-passed less frequently and because they can run in shorter gaps in line occupation than slower ones.

Apart from the effect of unpunctuality on costs, it may also affect the quality of the service offered. This is discussed in Chapter 12.

SUMMARY

1. *Freight trains should be kept moving between important traffic centres, with the minimum entries into marshalling yards.*
2. *Freight trains should move as quickly as possible.*
3. *Some sacrifice in the size of a train load may help to bring about items* 1 *and* 2.
4. *Special consideration should be given to traffic excluded from the faster trains.*
5. *Punctuality should be improved by striving for higher freight-train classifications.*

CHAPTER 12

Freight-traffic Transits

DURING the second world war, owing to shortages, quotas, rationing and other factors, British industry was obliged to work with smaller stocks of materials—at all stages of production and distribution—than those to which it had been accustomed. After the war, even when materials became more plentiful, there was no general wish to return to the level of stocking which had been common in pre-war days. Capital was in short supply, interest rates were high and there was no desire to have unnecessary amounts of capital tied up in large stocks especially as the cost of most materials and products had rocketed during the war years and continued to do so for some time thereafter. In addition, storage space was at a premium.

This affected the attitude of the trader to the transport of his goods. More than ever before, he required speed to minimize the quantity of stock in the transport pipe-line and reliability to guarantee the replacement of the small stocks held in his warehouses as these were consumed. These requirements often became more important than the cost of the transport, provided that the savings achieved by holding smaller stocks exceeded the extra cost of securing satisfactory transport.

The failure of railway freight transport to maintain sufficiently high standards in speed and reliability contributed to the loss of some traffic to other modes of transport, particularly to the " C " licence holder (i.e., the trader who conveys his goods in his own lorry).

The railway has combated this by introducing certain improvements in transits by various means including:

(*a*) An Assured Arrival Service. Where this type of service is operated the railways guarantee overnight transit of traffic between the points specified and, where applicable, delivery of the goods to the consignee next morning.

(*b*) Export Express Service. This is a similar service but is confined to traffic for export. It applies between specified stations and docks. A next-day arrival is guaranteed.

(*c*) Green Arrow Service. On payment of a supplement a wagon is accorded special supervision throughout its transit. Senders may be supplied with details of its scheduled arrival time at destination. Records are kept of the movement of the wagon throughout its journey.

The need is to extend this standard of service to cover all traffic. To maintain such standards would on occasions involve the railway operator in additional expense. It involves running a booked train even when there is only a small fraction of the train engine load. It means double-heading or running a *special* to clear the surplus when there is more traffic offering than the train engine is capable of hauling. In other ways, too, additional expense may be involved, but the provision of speedy and reliable transits can also save money. This is often overlooked. The most important saving is in the reduced amount of rolling stock required to do a given amount of work. The average round-trip time of freight rolling stock on British Railways falls a long way short of reasonable expectations. There are reasons for this, other than extended transits. But transits are one of the important factors. Other things being equal, a wagon performing three overnight transits of say 300 miles, is working three times more efficiently than a similarly loaded one taking three days for the same journey. As freight rolling stock is easily the largest single item of capital equipment employed by British Railways, there is scope for valuable economy. In addition, a reduction in freight rolling stock would naturally facilitate savings on maintenance and depreciation costs of sidings.

Another saving would be in the cost of putting surplus freight rolling stock into storage at off-peak periods, and taking it out again when the demand revives. Apart from economies in rolling stock, the adherence to booked working arrangements, even when freight trains are lightly loaded, would bring in its wake a more strict working to the diagrams of both engines and men, which might prove profitable in the long run. Another source of benefit to the operator would be a gain in traffic to those services which are at present under-loaded, in consequence of the better standard of service being offered.

Therefore, speed and reliability in transits is in the common interest of both carrier and customer. Some railwaymen have said that many customers are not really interested in speed, but only in reliability. It is true that consistency is the primary consideration, but is there a single trader who would prefer a slow transit as a regular feature rather than a fast one? In making the claim that speed is not essential, the idea behind it is that unreal accelerations in scheduled services may lead to a deterioration in reliability standards. It is vital, of course, that promises should not be made which are incapable of regular fulfilment. However, it would be wrong to assume that scheduled fast services are more difficult to achieve than scheduled slow ones. The fully fitted express freight train would ordinarily achieve a higher standard of punctuality than a slow unfitted train partly because of its

priority but also on account of its ability to run in sequence with passenger services and not to be shunted for their passage.

What then is a reasonable aim to achieve in transits in the near future? It is necessary to discuss only the transit of the wagons here. Delays in terminals have already been mentioned in Chapter 7.

The first objective is the provision of a booked service for as many wagons as possible. The task of doing this, though formidable, is not as great as it may appear, as there is a repetitive pattern in forwarding from most stations. A booked service is vital to ensure that:

(1) There is a standard against which actual performances can be measured.

(2) The range of connections which it is desired to maintain at a marshalling yard can be established, and the staff concerned made aware of them.

(3) Any sub-standard performance can be investigated, the cause ascertained and the defect remedied.

(4) Any injudicious routings which are still in operation may be brought to light. Good progress has been made in replacing the old Company routings by ones designed to give the best service. However, it cannot be assumed that the ultimate has ever been reached, as services are constantly being remodelled, and flows of traffic change.

Secondly, the average length of haul for goods traffic is only about 130 miles. There are very few journeys in excess of 400 miles. Many wagons are available for moving by 6.0 p.m. and are not required much before 5.0 a.m. It is not setting our targets too high therefore to say that overnight transit is a reasonable aim in the majority of cases. The only proviso must be that this can only be achieved where there is a reasonable flow of traffic.

Thirdly, with minerals and coal traffic the average journey is only about 50 miles. As this traffic is not handed over to the railway for conveyance at a specific time, one cannot be equally precise. A next-day arrival should be possible in the majority of cases, providing again that there is a reasonable and consistent flow.

Let us now consider the stages of transit and see why these targets are so far from being achieved at present and what can be done to improve things. It is convenient to deal only with goods traffic, as the problems with minerals are rather different, although much that follows will be equally relevant to full loads of mineral traffic.

THE LOADING PROCESS

The safe loading of the goods in the correct type of wagon is the first step. Failure to load safely results in wagons being stopped *en*

route for reloading. The use of incorrect wagons may have adverse effects also. One thinks immediately of unfitted wagons being used for transits involving journeys by express freight trains. One effect of the increase in the number of express freight trains has been a decrease in the number of trains, other than express freight, over the same routes. Therefore, a wagon unsuitable for conveyance by express freight train may have to wait many hours in a marshalling yard before there is a slow service. Even worse, the journey may involve staging through several intermediate marshalling yards, because the trains by-passing those yards are all express freight trains. Not all express trains have the vacuum brake in operation throughout the whole train, and on these services some unfitted wagons may be conveyed. However, some wagons are excluded from the faster trains altogether on account of the nature of their loads or because of a short wheel-base.

To reduce wagons stopped in transit for repairs, examination of the wagon for defects and pre-testing of vacuum brakes should precede loading when possible. After loading is completed, some wagons are conveyed direct from sending point to their destination. Transits in these cases are normally satisfactory. Trouble is more likely to be experienced when the journey consists of a feeder service to a marshalling yard, then a trunk journey (sometimes more than one) to another marshalling yard and finally a feeder service to destination. It is a typical journey of this kind that will be considered.

PLANNING THE SERVICE

Time is often wasted between the loading being completed and the departure of the primary feeder service. Some margin is necessary to allow for shunting out and assembling the train, but wasted time, before the journey even commences, augurs ill for the transits of the wagons concerned. This defect in the service may be noticeable particularly on Saturdays when loading is finished earlier in the day. In spite of earlier loading, some trains appear to run at the same times on Saturdays as they do the rest of the week, for timetable simplicity, rather than running at the times required to meet the needs of the traffic. It should be borne in mind that it is often at week-ends that transits are particularly bad. This will be referred to again later. The delay in the feeder-service departure may often be attributed to waiting for a path because of line occupation by passenger-train services. On weekday evenings the busiest of the passenger peak is over before it is necessary for the feeder services to run. The value of the passenger trains should be considered in relation to the effect that they may have on freight-traffic transits. It is not an over-statement to say that many

stopping passenger trains in the evenings are not profitable. Is it necessary that the advantages of good transits to railway net revenue, which have been outlined, should be prejudiced by the running at particular times of unprofitable passenger services?

Planning the First Feeder Services. The correct classification of feeder services can only be assessed according to local circumstances. The use of the highest possible classification is a good principle, but against the running time which can be saved must be set the extra time taken in joining up couplings and vacuum pipes before departure and the uncoupling at the marshalling yard. These features weigh particularly heavily on feeder services that stop intermediately to attach; i.e. pick-up trains. It depends to a great extent on the nature of the service on the line over which the feeder service passes. By achieving the best classification possible a path may be available a good deal sooner than a path suitable for an unfitted train.

In the Marshalling Yard. When the wagon has arrived at the first marshalling yard a speedy transit can be achieved most efficiently by reducing the time it spends in the yard to a minimum and by despatching it direct to destination or as close to its destination as possible. Reliability at this stage means the avoidance of damage and the maintenance of booked connections. To reduce the time spent in the yard, the trunk service must depart as soon as its load is assembled.

Planning the Trunk Services. At the larger yards there will be a number of trunk services available to leave at more or less the same time. At this stage, it is as well to realize that with long distance journeys, it is necessary to plan the transit according to the time the wagons are required at the destination station and work backwards in planning to the originating points. Only by this means can the maximum number of fast transits be obtained and the latest possible loading times be secured. In many cases wagons reach destination several hours before unloading begins and the trains concerned can afford to run later than at present, thus leaving the track free for trains to run to other points to give overnight delivery where it has not previously existed. There is scope for adjustment of services, bearing these points in mind.

In planning the departure of the trunk services it may be found that connection cannot be maintained with all the feeder services which ideally should be secured. The vital thing is to ensure that the overnight service of the majority of the wagons is not discarded by waiting for late arrivals. It will often be desirable for the trunk service to be booked to depart when the bulk of its potential load is assembled. Special action is required to schedule the best possible service to the minority which are unable to connect into the main trunk service.

The lines of enquiry to be followed for these wagons are:

(1) Can loading be completed earlier to enable the wagons to be despatched to the marshalling yard by an earlier feeder service? With wagons of sundries which are only partially loaded at this time, it may prove beneficial to despatch the wagon, so that a proportion of the goods receives an overnight service. The balance may be conveyed by a later service or held until next day according to circumstances.

(2) Can the feeder services conveying the wagons run earlier than at present or can they be accelerated?

(3) If neither (1) nor (2) is practicable, what is the best alternative service that can be provided in place of the main trunk service?

There are few exceptions to the principle that the trunk service should run at the highest classification possible.

The running of more trains under express-freight conditions is not justified if the effect is likely to be harmful to the service provided for important flows of traffic loaded in vehicles unsuitable for conveyance by those trains. This applies to iron and steel traffic and to traffic in those privately-owned tanks which are not suitable for certain express-freight speeds. The railway share of oil traffics is small in relation to the total, and nothing should be done to prevent the volume of it being increased. However, if for reasons previously outlined, trunk services are not planned to run under fully fitted conditions, the circumstances should be reviewed periodically to ensure upgrading of the trains concerned at the first opportunity.

Planning the Final Feeder Service. On arrival of the trunk service at the final marshalling yard, connection must be secured with the final feeder service to the ultimate destination. The departure time must be the latest which will permit the traffic to reach the destination station and be positioned before unloading time. By selecting the latest time, the maximum number of connections may be made and the greatest allowance given to provide for the possible late running of trunk trains.

Planning Working Arrangements at Week-ends. Before leaving the planning of the service let us refer again to transits where a week-end intervenes. There is a danger that in searching for short-term economies actions may be taken which extend transit times and, in consequence, the economy may be more apparent than real. The closing of marshalling yards on Saturday night to Sunday morning and/or Sunday night to Monday morning, as well as the cancellation of freight trains during the same period, may seriously extend transits. Such actions can be justified only when they are so arranged that transits are not adversely affected. On the other hand, if their effect is that goods which

should be unloaded and delivered on Monday are not available until Tuesday, the following difficulties will arise:

(1) Wagon utilization will be worsened.

(2) The risk of losing traffic to speedier forms of transport will be increased.

(3) The under-employment of terminals and cartage on Mondays which is already a feature of goods-station working at some places will be accentuated.

A good test to apply is to examine the 6.0 a.m. stocks at marshalling yards on Monday mornings. By this time most traffic should be in the goods terminals. A standage of consequence in yards at 6.0 a.m. on Monday, or any other morning for that matter, is worth investigating to see if better transit arrangements can be made for the traffic concerned.

CAUSES OF EXTENDED AND UNRELIABLE TRANSITS

In the foregoing paragraphs the planning of the service has been considered and it is now necessary to examine the reasons for the breakdown of booked transits. Each is dealt with under a separate heading in the following section of this chapter.

FIRST FEEDER SERVICE

The first feeder service may be missed owing to:

(1) Loading, labelling, sheeting, etc., not being completed. To put this right, an examination of the cartage and terminal arrangements is required and sometimes it may be necessary to approach the trader to discuss the possibility of the goods being handed over slightly earlier. If by making the goods available earlier, delivery next day can be given instead of a two-day transit, most consignors would be eager to assist.

(2) Loading, etc., completed but wagon not cleared. This calls for a scrutiny of the loading and shunting arrangements. If loading is performed intelligently, it can minimize the amount of shunting to be done when the loading staff have finished work and the shunters take over. Alternatively, it may be that an intensification in the supervision of the shunting work is required.

(3) A wagon being shut out owing to the feeder service being fully loaded. Ordinarily, feeder services are rarely fully loaded and this question is of far more importance with trunk services; however, it is a possibility not to be overlooked. The diagnosis should follow that proposed later for the trunk service which is fully loaded. See paragraph 3 under *Trunk Service*.

TRUNK SERVICE

Connection may not have been achieved with a scheduled trunk service for any of the following reasons:

(1) Because the feeder service or the previous trunk service, where more than one trunk service is involved, was late into the marshalling yard. The first question to ask is " Did the feeder service start out punctually?" If it was late, was it due to waiting traffic, waiting motive power or other causes? If the reason was waiting traffic, was it a case of extending the transits of many wagons for the sake of one or two? If the departure was punctual, the causes of delay *en route* require examination, and it is particularly important to expose and eliminate the delays which are occurring frequently. In these inquiries the question of priorities between the feeder trains and passenger trains, which may be lightly loaded, may have to be resolved.

(2) Delay in shunting feeder services at the marshalling yard or a wrong shunt. Investigation may reveal that delay in shunting was due to the late arrival in the yard of other feeder services, and where this is so the origin of these delays must be traced as set out in the previous paragraph. Less often the fault may be found in the operation of the yard itself. It is imperative to establish that the yard is capable of making all the connections which the plans envisage, under reasonably adverse conditions. In fact, the whole of the planning throughout should be capable of fulfilment with the everyday type of unfavourable conditions such as bad weather, heavy traffic, slight delays, etc. This is the very essence of reliability.

The number of delays caused by wrong shunts would form only a small percentage of the total. However, there is a great need for the education of shunters and yard supervisory staff in the importance of transits, a need shared by many other grades in timetable offices, control rooms, in goods depots and other places.

(3) The wagon may have been excluded from the trunk service, because the train was fully loaded. Consider these points. Was the diagrammed motive power supplied? Is the diagrammed motive power adequate? Is the train classification suitable, remembering that the load will tend to decrease as speed increases? Is an unbalanced engine and crew available for double-heading? Is a duplicate train justified and if so what is the most advantageous time for it to run? Better results will be achieved if a *Q* path is scheduled in the W.T.T. in cases where a duplicate train is required periodically. Finally, it is as well to check that the allegedly fully loaded train was in fact loaded to capacity. In the hurly-burly of the peak period in a marshalling yard

it is not easy to know exactly when to drop a brake van on a load, bearing in mind that a train load does not necessarily comprise a number of wagons but may be an equated number according to the loading of the wagons.

Advanced Traffic Information. One of the fundamental problems in obviating traffic being left behind because the train service is fully loaded is the inadequacy of information available to certain yard masters and Control offices concerning the traffic which is converging on a yard. At many places at present, the staff can rely only on their previous experience, and on any special information given to them by the staff at the sending points concerning heavier-than-usual flows of traffic. For the immediate future it is vital that staff at sending points should be educated to give such information to Control offices and that the latter should pass it on to all concerned. Looking ahead one must wish for, and work for, an adequate communications system that will take the surprise element out of the loading of freight trains—which bedevils operations in many parts at present. When this is done supplementary services can be arranged more scientifically and in sufficient time for all traffic to reach destination punctually.

(4) The wagon may have been excluded because it was not suitable for conveyance by virtue of the classification of the trunk train. Earlier mention has been made of the importance of the use of fitted wagons. In addition the loaded wagon may be deemed unsuitable by reason of its construction, or on account of the load it conveys.

FINAL FEEDER SERVICE AND PLACING

Connection may have been missed with this service on account of the late running of the trunk service, delay in shunting at the marshalling yard or because the final feeder service was fully loaded before the arrival of the wagon. The lines of inquiry are similar to those previously set down for the trunk service. There is just one point to emphasize in particular. That is—the importance of prompt despatch of trunk services. Failure to do this may not only result in the particular trunk service arriving sufficiently late as to prevent its connection with the final feeder service, but may react on other trunk services with similar consequences to the traffic conveyed by each one.

In discussing the planning stage, it was stressed that the transits of the bulk of the traffic should not be jeopardized by trying to secure connections with one or two late arrivals. In executing the plan this can easily be undone by trying to maintain connections with wagons arriving behind their scheduled time. It is sometimes said that to secure satisfactory transits, connections in marshalling yards must be as in-

violate as are connections between passenger trains. This must not be taken to mean that connections for the late arrivals are secured at the price of all the traffic on the trunk train arriving at destination late. A solution must be found which will not prohibit punctual starts of trunk trains from yards. Also, in the discussion on planning, it was stated that the starting point in the plan must be the time the wagons were required at destination for unloading, thereafter back-timing to secure the latest loading time. This means that the late running of the final feeder service could undo all the good work that has been achieved in the earlier parts of the transit; this must be avoided.

Similarly, there is little margin for the occurrence of any delay in positioning at destination. The most common cause of delay in positioning must surely be those wagons which have not been unloaded the previous day taking up the space required for the new arrivals. The question of leave-overs at goods terminals was discussed in Chapter 7. Delay in placing could also be due to inadequate shunting-engine arrangements.

A fairly typical journey has been traced through, and an examination made of some of the more common causes of delay. There are still important ones which have not been mentioned. Of these, the most important is the cancellation of booked services.

CANCELLATION OF BOOKED SERVICES

Cancellations may be prearranged or may be made by Control at short notice. The prearranged cancellation is often caused by additional passenger-train programmes at holiday times or for special events such as football matches and so on. The circumstances in these cases are quite different from those of the lightly loaded passenger trains mentioned earlier. The passenger trains concerned are frequently quite profitable ventures and there may be every justification for them taking priority over the freight trains at particular times. It is vital, however, that when such cancellations are made, scheduled replacement services should be planned to cater for the traffic concerned. In many of the cases the cancellations are at week-ends, mainly on Saturdays.

Similarly, cancellation of freight trains for engineering work often take place on Saturday night to Sunday morning. There is often no excuse for these cancellations to lead to extended transits. Replacement trains could, and should, be run. At week-ends there is from midday on Saturday until say 5.0 a.m. on Monday; i.e., 41 hours to make a transit, as compared with about 11 or 12 hours between working days throughout the week. There is often plenty of spare line capacity on Sunday night to Monday morning which could be used to run replace-

ment trains. This is not always a particularly expensive time for train operation. Some additional cost would be involved, but against this must be offset the customers' gain and the operators' gain which result from reliable transits. Cancellations of this kind provide further causes of extended transits at week-ends.

Short-notice Cancellations made by Control

Control offices must likewise run specials in replacement of trains which they have been obliged to cancel at short notice. It has been said previously that the Control must not be permitted to cancel trains which comprise part of the transit schedule for particular wagons, on account of small train loadings. The other main causes of cancellations are: (*a*) mishaps; (*b*) shortage of motive power or staff, or after engine failures; (*c*) fog and other adverse weather conditions.

If Controllers know the details of the transit schedules there is a great deal which can be done to prevent these incidents from causing extended transits, and when some delay is unavoidable the extent of it may often be minimized. It should also be possible for the destination stations to be advised of the cause of any delay and the estimated time of arrival of the wagons concerned. Again, the priority between passenger and freight services has to be balanced. After mishaps, in some places there has been a tendency to keep all passenger trains running and to cancel the freight trains if, for example, one running line is blocked and trains in both directions are being worked over the one line that remains in use. In circumstances like this it would not necessarily be to the passengers' disadvantage to be conveyed part of the journey by road and to keep as much freight traffic on the move as possible.

DECELERATION OF BOOKED SERVICES

If the classification of a train is reduced causing it to run at slower speeds than those specified in the W.T.T., there may be adverse effects to transits of traffic on that train and also to traffic on other trains which are delayed in consequence. Deceleration may result from:

(*a*) Motive power being supplied which is not suitable to run at the scheduled speed. It is necessary in this event to ascertain if the diagrams are satisfactory in practice. If they are not, a suitable revision should be made to them. If they are, an examination of the working of the motive-power depot might indicate the cause of the trouble.

(*b*) The nature of the traffic being conveyed. If a destination is served directly only by an express freight train and there is some traffic offering for that destination which is not suitable for conveyance by that particular class of train, one method of avoiding the traffic being staged through intermediate yards, and thereby suffering an extended transit,

is to decelerate the express freight train concerned. In certain cases this may be possible with benefit to the particular traffic and without detriment to any other traffic. In other instances the transits of many other consignments may suffer for the benefits of the particular traffic, and in these cases other plans should be made for the offending load.

(*c*) The size of the load. It has already been mentioned that the maximum load which may be conveyed tends to decrease as the speed increases and vice-versa. Faced with the problem of a fully loaded train and wagons left over, one answer might be to reduce the classification of the train thereby permitting it to convey more wagons.Occasionally this may be done without detriment to other traffic, but again one must guard against improving the service for a small volume of traffic at the expense of a greater volume.

WAGONS STOPPED EN ROUTE FOR REPAIRS OR RELOADING

Adequate examination and preventative maintenance of wagons and skilful loading will reduce the number of these incidents. When they occur it is necessary to make arrangements for the repairs or reloading to be carried out with the minimum of delay. As far as possible this should be done without deviating from the scheduled service. Where repairs to a wagon cannot be done immediately, it may be beneficial to transfer the traffic to another wagon or, if necessary, to a road vehicle to avoid delivery to the customer being behind schedule. When it is not possible to avoid some delay, the destination station and the consignee must be advised at once and be given a revised arrival time.

TRAIN LOADS BEING STABLED EN ROUTE DUE TO THE INABILITY OF THE TERMINAL OR AN INTERMEDIATE YARD TO ACCEPT

Everything possible should be done to avoid this situation arising. In the case of terminals, steps should be taken to increase the rate of work to speed up acceptances. If necessary, traffic should be diverted to other terminals. In serious cases it may be necessary to impose forwarding or loading restrictions on all stations which have traffic for the terminal concerned, but this should be a last resort. Loading restrictions (i.e., stopping wagons being loaded for the congested terminal point) are more satisfactory than forwarding restrictions, which involve the wagons standing under-load at the sending point instead of at destination. When an intermediate yard is unable to accept loads on account of congestion or mishaps, special attempts should be made to divert such traffic as normally passes through the intermediate yard. This involves special

shunting being done and may also necessitate the running of smaller train loads.

INCORRECT LABELLING AND LOST WAGON LABELS

Care is needed in the labelling of wagons to show the correct destination and the correct route. One of the most common causes of error arises where more than one destination has the same name; e.g., Newcastle, Newport, Bradford. Wagons are labelled on both sides and if the labels are properly secured, there should be few cases of delay arising from lost labels.

Conclusion. There is no doubt that as marshalling yards become mechanized, motive-power units modernized, and as the proportion of vacuum-brake fitted wagons increases, it will become easier to provide quicker and more reliable transits; this will also be aided as the number of marshalling yards is reduced and freight depots concentrated. It is also true that there is much that can be done immediately. The first step is to establish scheduled transits for as wide a range of traffic as possible and to review them frequently in order that progressive improvements may be made. It calls for an intense effort to educate staff at all levels concerning the importance of good transits, and to ensure that the supervision is good enough and adequate to see the job through. The proposed methods outlined earlier for the planning and performance of transits are just as valid after plans for concentration and the modernization have been completed. In addition, by that time one would hope to see a much closer record taken of the movements of individual wagons (see Chapter 3, page 58). A new role for the Control office is envisaged in which the maintenance of scheduled transits would be a prime duty. Recent achievements (e.g., the Assured Arrival Service, the Export Express Service, etc.) have records of which the railways can justifiably be proud. The advance should continue. The wider the front, the greater the gains that will be reaped.

SUMMARY

1. *Speed and reliability in transit times are in the common interest of customer and operator.*
2. *Scheduled transits for maximum number of wagons are necessary.*
3. *Overnight transit is the target.*
4. *Don't waste time between end of loading and beginning of transit.*
5. *Avoid marshalling yards.*
6. *Guard against passenger services extending freight-traffic transits.*
7. *There is a method of overcoming almost all difficulties which lead to the breakdown of scheduled transits.*

CHAPTER 13

Passenger Train Services

IN addition to normal passenger traffic, passenger train services are designed to convey freight on which a higher rate than that charged on freight-train services is demanded.

As many members of the community have now become car owners, the pattern of passenger travel has changed. Coincident with this, the average length of rail passenger journeys has increased. One reason for this is that the advantage of rail travel becomes more pronounced over the longer distances. Many people who would not consider using the train for a 10-mile journey, may prefer it for a journey exceeding 200 miles. This increase in the average length of journey should be welcomed by the operator, as the cost factors weigh more in his favour as the distance increases. The service which is likely to attract a good patronage will be one that is competitive in price, frequent and punctual as well as convenient, giving a fast journey in safety and comfort.

The main competitive forms of transport are by private car, by air-lines or by motor-coaches or buses. Many car owners count only their fuel costs when comparing the cost of using their car with that of public-transport charges. However illogical it may be to ignore depreciation, tyre and engine wear etc., it is as well that the public-transport operator should recognize this attitude when fixing his fares. A car has a particular advantage when passengers are carried as well as the driver, as the costs may be shared between the people conveyed.

The operating costs of air-lines are high. In the past it was by virtue of the speed of their services rather than in cost that they were most competitive. But the disparity in the air and rail fares has been progressively reduced as air-line efficiency has improved.

The fares by public road transport are frequently below standard rail fares. On long-distance coaches this is usually achieved by obtaining a high load factor. This can be more readily attained as they enjoy the flexibility of comparatively small unit loads. This is an advantage shared by the air-lines. A decline of 20 or 30 passengers may permit a reduction to be made in the number of vehicles employed, but in rail transport in the same circumstances costs are likely to remain constant. Clearly the rail operator must pay constant attention to the costs of providing rail services in order that fares may be kept down.

Safety. Rail transport is undoubtedly superior to competitive forms of transport from a safety point of view. Although efforts must not be relaxed to maintain and improve the splendid safety record of railways, it is not a considerable selling point. Most people do not pause to consider the relative accident statistics before deciding which form of transport to use.

Punctuality is so important to the passenger and to the operator, and at the same time is so difficult to maintain, that the whole of Chapter 14 has been devoted to it.

Speed. Provided that they are determined to do so, the railways can offer greater speed than the motorist can hope to achieve, except when he is travelling on a motorway. To offer higher average speeds which are only slightly greater than those obtainable on the road is not enough. Speeds must be considerably faster, as the car is often garaged only a few seconds away from the breakfast table, or business desk, whereas the station may be a considerable distance away. On a journey of 150 miles, a train, which averages 75 miles an hour takes two hours, but if getting to the station takes half an hour and another half an hour is absorbed in getting from the arrival station to the final destination, the over-all journey is not appreciably faster than many motorists might hope to achieve over good roads. On shorter journeys the comparison is less favourable to rail transport; on longer journeys more favourable.

Although rail transport cannot equal air-line speeds between two points, it may be able to achieve parity in over-all journey time. The most serious aspect of air competition is that it tends to entice the long-distance passenger, who is the most profitable railway traveller. Speed is essential to counteract this threat. Very high running speeds and ruthless elimination of intermediate stops must be the rule over those routes in direct competition with air-lines.

Speed is an attribute which is beneficial to the operator as well as being a feature which the passenger seeks. It is produced by the employment of high-speed motive power on schedules which exploit its speed capacity to a considerable degree, but it must not be so high that punctuality suffers. Fast journey times cannot be obtained where there are frequent intermediate stops and these should be kept to a minimum. Where they are essential they should be kept to the least duration. With locomotive-hauled trains, fast speeds are produced more easily with small train loads than with large ones. Small loads are consistent with a frequent service, as passengers may be expected to dispose themselves over a greater number of trains.

Frequency. Even if the over-all journey time by rail is a good deal

faster than by road, it will still not appeal to the potential passenger unless a train leaves close to the time at which he wishes to travel. As the needs of individuals vary, the only way this can be assured is by having a frequent service. The rolling stock employed in providing passenger services is usually related to the daily or seasonal peaks. Therefore, to provide a frequent service does not normally necessitate the employment of additional units; it is a matter of making the best use of them by keeping them moving. The main limitations in providing for frequent passenger services are:

(1) Line occupation. The occupation of the track should not be so intense that punctual working is forfeited. It is also important to consider the effect that a proposed frequent passenger service is likely to have on the working of freight trains and traffic.

(2) Inadequate demand. Although most movement costs tend to fall as utilization increases, it has already been established that certain items increase roughly in proportion with mileage; e.g. fuel. There is no economy in continuing to run passenger trains which regularly fail to meet their movement costs.

Regular Interval Services

A frequent service of trains which run at equal intervals of time are popular with passengers who travel frequently as they know at what time they may catch a train without referring to a timetable, or calling at an enquiry office. This type of service also has many operating advantages including:

(1) Providing it is planned properly, it leads to the maximum utilization of the units of operation.

(2) Train regulation is made easier, since operation assumes a repetitive pattern.

(3) If the timing of the intervals is intelligently planned to avoid conflictions at junctions and in station working, this will continue throughout the whole service as the pattern is repeated. The same platforms may be allocated throughout the day with benefit to passengers and station working.

(4) Those interval trains on the fringe of the peak periods may entice a number of passengers away from the peak itself. Naturally, the interval service has to be supplemented during peak periods.

The draw-backs of interval services include:

(1) At some smaller stations, stops may be justified only on certain trains, but the rigidity of the pattern does not permit the arrangement of stops to be varied, except on a very small scale.

(2) Station allowances have to be standard throughout the day, although the traffic may vary from train to train.

(3) Certain trains may not cover their movement costs but they must run if the interval service is to be maintained.

(4) The evening services may tend to be inadequately patronized. At this time of day the line capacity may be required for the movement of freight traffic which requires overnight transits.

When these difficulties arise it may be desirable to vary the intervals at certain times of the day; e.g. to widen the intervals during the evening. With the longer-distance services in particular, people prefer to travel at particular times of day. It may be established that although there is sufficient patronage to justify a train to station Z, 200 miles away, at 8.0 a.m., 9.0 a.m. and 10.0 a.m., there is not sufficient patronage at 11.0 a.m. Therefore it become necessary to introduce a two-hourly gap between 10.0 a.m. and 12.0 noon. This type of service is known as an *even-time departure system* because the trains leave at fixed times in the hour, but not at equal intervals. This type of service has certain of the advantages of an equal-interval service, but to a lesser degree. To counterbalance this, there is a gain in flexibility.

Through Services

The private car takes its passenger from door to door. A rail journey involves at least transfer to and from rail vehicles at the beginning and end of the journey. Train services should be designed to reduce the number of changes which passengers are required to make during the rail journey itself. Regular analyses should be made of traffic flows to enable this to be done, but a certain amount of interchange is unavoidable. This is yet another reason why the operator should be prepared to run a service with fairly small train loads. Small trains can operate between certain points where large trains would not be justified. The provision of through services for as many passengers as possible is to carry out the first principle—*Keep Traffic Moving*. In doing it one tends also to keep the mobile equipment moving and thereby reduce working costs.

Failure to provide through services may result from passenger train plans being drawn up on a district, area or even a line basis. Unless these are properly integrated with the services of adjacent areas or lines, unnecessary changes and poor use of equipment may result.

Where through trains cannot be justified between two points it may still be possible to run through coaches. A train may be made up of two or more portions for the major part of its journey. At a suitable junction the portions can be separated and run to their respective destinations independently. In the return direction they run independently to the junction, there to be combined into a full train for the main part of the journey. This system combines the advantage

of through services for the passenger with the benefit to the operator of a good train load for most of the journey. It is most conveniently performed with multiple-unit stock—as with separate locomotives, extra movements are involved in splitting and combining the sections. This extends journey time and lengthens the occupation of platforms at the junction.

Seating of Passengers

Another feature is that train travel enables passengers to avoid the strain of driving, the frustrations of road congestion and the parking problem. If efficiently organized, a rail journey may be a restful period, or alternatively an opportunity to work or read. Meals may be taken during the longer journeys thus saving the passenger's time. These benefits in favour of rail transport apply only when each passenger has a seat; efforts should be made to guarantee seats for travellers over the longer distances. Reservations of seats in advance should be encouraged. Restrictions on the number of passengers, according to the number of seats available on a train is another method of guaranteeing seats. In this case the authority for a passenger to join a particular train may be a regulation ticket, which is obtainable in advance. The strength of the demand for seat reservations and regulation tickets is a useful indication of the need for additional or relief trains. The operator must take all possible steps to assess what the demand will be. He should be assisted by the record of use made of trains on a previous similar occasion. Provided with a good assessment of needs, he should then plan to offer a seat to each traveller. For other aspects of convenience and comfort see Chapters 4 and 6.

MAIN TYPES OF PASSENGER TRAINS

The most convenient way to classify passenger trains is into four main groups: (1) express; (2) semi-express; (3) suburban; (4) stopping trains, other than suburban. These classifications will be dealt with under separate headings in the following section.

EXPRESS SERVICES

Express trains are those that run over long distances at high speeds with few intermediate stops. They serve only the larger towns and very often they run to and from London. It is only between large centres of population that passengers travel in sufficient numbers to justify them. In view of the emphasis previously placed upon reducing operating costs by high train speeds and maintaining movement over long distances, it is not surprising that this is usually the most profitable

of the four groups. Much of the coaching stock used on daytime trains should be able to achieve 600 to 800 miles a day, according to the length of the journeys. Where the service does not permit particular sets of coaches to achieve high mileages, it may be advantageous to extend the sets beyond the normal extremities of the service, thus providing more through services for passengers and giving better coaching-stock utilization.

SEMI-EXPRESS SERVICES

Where the number of passengers does not justify express trains, semi-fast trains stopping at most of the more important centres of population may be the only service which it is economical to operate. This is unlikely to provide a good service for through passengers but may be satisfactory for people between intermediate stations.

Semi-fast trains may act as feeder trains to the express trains on other lines. Alternatively, an express from *A* to *G*, may stop at station *D* only; the semi-express preceding it will stop at *D* and bring to that point passengers from *B* and *C* to join the express at *D*. After stopping at *D*, it might follow the express, setting down at *E* and *F* passengers from *A* who had transferred at *D*, as well as providing the service from stations *E* and *F* to *G*.

If cross-country trains are only semi-express, it may lead to an unnecessarily large number of passengers travelling via London, and thereby being enabled to use express trains. This often gives a faster journey—though a longer one—than the more direct cross-country train. It is necessary to be particularly careful in designing cross-country services not to permit an unnecessary number of stops. These trains also tend to have long station stops at the more important junction stations, in order to connect into and out of other trains. It may be that by speeding up cross-country services more people may be persuaded to use them over long distances, thereby providing adequate patronage with fewer intermediate stops.

The main users of the express and semi-express services may be roughly divided between business, casual and holiday travellers. *Business travel* is fairly constant throughout the year and is reasonably even from Monday to Friday. It is demanding in the quality of service required but is prepared to pay well. The absence of major peaks and a good revenue prospect makes it a most desirable traffic. For distances up to 300 or more miles there is often a demand for services in the early morning to take passengers to business appointments and for services to take them home in the evening. *Casual travel* tends to increase at week-ends and is heavier in summer than in winter. However, many

casual travellers can be encouraged to travel in mid-week or other off-peak times by the offer of reduced fares.

Holiday travel presents serious peak problems as most of it is in the summer and at Bank Holidays and a great deal of it is concentrated on a few Saturdays during the school summer holidays. Wakes weeks and similar practices, which involve many people in particular areas causing them to take the same holiday period, necessitate substantial supplementing of the normal train services and create local terminal and line-occupation problems as they occur.

Sleeping-car services often fall into the semi-express categories. Except over very long distances, most of the passengers are not in a particular hurry. Their main desire is to depart and to arrive at reasonable times and to be enabled to get a good night's sleep in between. This is fortunate for the operator in those cases where the track is being shared with freight trains, as it should permit the sleeping-car trains to run at similar speeds to the freight trains and thereby reduce by-passing, which is detrimental to the freight service and increases the cost of providing it. The majority of sleeping-car passenger journeys do not exceed 400 miles and therefore an average speed of 50 miles per hour will enable most journeys to be completed in 8 hours.

Sleeping-car trains tend to be less profitable than other long-distance passenger trains because of the reduced capacity per vehicle, provision of attendants, laundry expenses, cost of booking arrangements, etc., and because the stock is inactive throughout the day. This may be partly off-set by making supplementary charges. But there appears to be a case for some convertible passenger vehicles (see pages 72 and 73).

The demand for car-carrier services is often greatest at night time, and in consequence these trains often convey sleeping cars. Because of the considerable bulk of a car and the fact that the car driver requires separate accommodation for himself and his passengers, the loading of trains provided exclusively as car-carrier services tends to be much less than that of an ordinary train. It is necessary to ensure that vehicles which carry the maximum number of cars are used. The economic value of the train will depend on whether it can attract sufficient traffic to enable the stock to be kept working most days of the week. Accompanied cars are a traffic that is subject to peaks. It tends to be greater in summer than in winter, and even in summer is much heavier at week-ends than in the middle of the week.

SUBURBAN SERVICES

(*a*) *Peaks.* The problems of the morning and evening peaks overshadow all other aspects of suburban train working. The size and

number of all the units of operation must be influenced by the peaks. By the nature of the traffic, frequent stops are necessary and therefore the two main considerations are: (1) rapid acceleration and braking of trains; (2) quick loading and unloading at stations. These services are normally worked by multiple-unit trains. It is essential to use large trains during the peak hours if the line capacity is to be adequate to meet the demand.

As considerable numbers of people wish to travel between the main termini and the various suburban stations during the peaks, many trains may run non-stop or with limited stops to and from the outer perimeter of the suburban area during this time. This gives the best use of all units of operation at the time when it is of most importance. Where express and semi-express trains share the track with suburban trains, equalization of speeds of all trains gives the best line capacity.

(*b*) *Off peaks.* At off-peak times it is important to reduce the size of the trains to keep the load factor to a reasonable level. By reducing the size of trains in service, vehicles are released for maintenance and cleaning, thereby reducing the total stock required. It is important that trains running in the off-peak times are examined from time to time to ensure that the receipts are at least covering the running costs. In order to achieve a reasonable passenger load and at the same time to provide a sufficiently frequent service to attract passengers, it is likely to be necessary for trains to make more intermediate stops during the off-peak periods than in the peaks.

STOPPING TRAINS (OTHER THAN SUBURBAN)

With the closure of many small wayside stations and branch lines, the number of stopping trains should be progressively reduced. This is important as they are often uneconomical because they incur high running costs on account of poor utilization of equipment and staff which results from the slow over-all journey time (the consequence of frequent intermediate stops). In rural areas this may be aggravated by traffic being inadequate during parts of the day to meet the running costs, thus forcing equipment to be kept standing idle.

Except for passengers connecting into and out of long-distance trains, the fares paid by the users of the foregoing services are often small. The withdrawal of these trains on branch lines, together with the concentration of freight traffic (see Chapter 7) may permit the line to be completely closed, which gives appreciable savings in track and signal costs. Where branch trains connect with main-line trains at a junction there is a danger that some passengers may be lost to the main-line services as a result of the withdrawal. However, the extent

of this is often exaggerated and it can be counteracted by the provision of adequate car-parking facilities at main-line stations and by running a good bus service between places on the branch and main-line stations. On main lines with dense traffic the benefits of withdrawing stopping trains may be even greater as they are one of the most expensive in terms of line occupation. By withdrawing trains of this kind, a greater number of expresses, which are more likely to be a profitable activity, may be instituted if demand is likely to justify it.

The quicker acceleration and turn-rounds of multiple-unit trains has permitted the services on many lines to be improved as compared with those provided by steam locomotives and coaches. This has often brought about a substantial increase in receipts. In spite of this and the reduced cost of operation, certain services may still be unprofitable. Legislation may restrict the operator in abandoning those activities which are uneconomic, but it is important he should be aware of the economics of each service. After all steps have been taken to turn deficits into profits, he should constantly strive for the withdrawal of the trains concerned.

Methods of reducing the cost of operation include:

(1) Employment of conductor-guards, who issue tickets on the train and thereby permit a number of the stations served to be unstaffed halts. A logical development of this, which has not yet been tried in Great Britain, would be for the driver to issue tickets and for guards to be dispensed with.

(2) The use of trains, which are very cheap to run, such as rail buses (a four-wheeled rail vehicle) or small lightweight multiple-unit trains.

Unfortunately where the number of passengers is small enough to permit these methods to be employed successfully, the revenue is unlikely to be sufficient to meet the costs, bearing in mind the formidable expense of track and signalling.

PASSENGER-RATED TRAFFIC

There are certain traffics for which the sender is prepared to pay a high rate in order that it may be conveyed by passenger train or an equivalent service. It may be that as the service offered by freight trains improves to give overnight transits to more traffic, there will be a transfer of traffic from passenger services to freight services. In view of the effect of parcels traffic on passenger station working (Chapter 6, page 111) and on passenger train punctuality (Chapter 14, page 235) this is to be welcomed. However, there will always be some traffic which requires a faster service than that provided by freight trains; e.g., newspapers.

Methods of Rail Conveyance of Passenger-rated Traffic

(*a*) A large number of parcels are conveyed at some stage of their journey in the guard's brake of passenger trains.

(*b*) Some traffic is conveyed in special vehicles attached to passenger trains. This is necessary where there is too much traffic for the guard's brake or with large individual consignments; e.g. motor cars.

(*c*) Much of the conveyance of passenger-rated traffic is done by the provision of fast trains, operating like passenger trains, especially for the transport of parcels, mails, newspapers, fish, etc. This increases the cost of conveyance, but when traffic is taken away from passenger trains, the working of the trains can often be improved. Where parcels traffic is dealt with at parcels concentration depots it is necessary to use parcels etc. trains, as the passenger trains do not serve them. Owing to the limited brake space in multiple-unit trains and the unsuitability of many of them to haul tail vehicles, special trains for passenger-rated traffic are often run in conjunction with them. As the service provided by parcels, etc., trains is necessarily less frequent than the passenger-train service, the speed of transits is often inferior to that given by passenger trains.

There are a few multiple-unit parcels trains employed in the conveyance of passenger-rated traffic. Such units normally have a sufficiently high power/weight ratio to permit them to haul other vehicles.

Main Types of Passenger-rated Traffic

The main types of passenger-rated traffic are classified in paragraphs (1) to (9), which follow.

(1) *G.P.O. letter mails and parcels post.* Although this traffic is carried by legal obligation, it is in fact a good traffic from the operator's point of view. It is a regular traffic with a regular pattern and has only one really serious peak; i.e. pre-Christmas. No weighing or documentation is required (charging is based on Post Office records) and therefore it does not need to enter parcels offices. Almost all the cartage to and from stations is done by the G.P.O. The amount of handling and sorting is small. The usual arrangement is for letter mails to be transferred to and from rail vehicles by G.P.O. staff and for parcels post to be loaded and unloaded by railway staff. However, there is some assistance given by both sides in certain places.

The Post Office Act 1953 entitles the Postmaster General to demand that trains run at times suitable to him, but there is good co-operation between the Post Office and the railway in formulating a programme which is mutually convenient. Sometimes G.P.O. mail trains are run exclusively for this traffic; at other times it is conveyed on passenger trains. The booked services for mails and parcels post are defined

in schedules which are distributed to all concerned. Security is an important issue and mails are normally loaded in the guard's brake or in a locked compartment.

For parcels up to 15 lb. the Post Office is in competition with the railway. Many of those which are handed to the Post Office, pass in mail bags for part of their journey by rail. The income to the railway per parcel is less in these circumstances but the expensive processes of weighing, documentation, sorting and cartage, which are normally required for ordinary parcels are obviated.

(2) *Newspapers* are one of the most urgent traffics conveyed by rail. Absolute punctuality of the trains conveying them is vital. It is a good regular traffic which requires little weighing and documentation (most of it is carried under contract) and is mainly conveyed to and from stations by the customer.

(3) *General Parcels.* This is the most important group from the point of view of revenue earned, but the cost of dealing with general parcels is higher than with mails and newspapers as in addition to rail conveyance there is often collection and delivery by road to perform. The most common consignment is of an individual package, and the majority are less than 28 lb. in weight. In consequence, considerable sorting and handling is required and there are various documentation processes to be performed. As a result, much of the expense of dealing with the traffic is incurred outside the rail journey itself.

(4) *Fish Traffic.* Most of the traffic is concentrated at comparatively few ports and therefore it is possible to deal with much of this traffic initially in through-train loads from the port to convenient centres of distribution. After leaving these centres more complex problems are involved as single van loads, or even a few boxes of fish, may require transporting by ordinary passenger or parcels train to their ultimate destination. This traffic is most demanding in respect of speed of transit, and road transport is highly competitive over the shorter and medium distances as it has the advantage of delivery direct to the customer's door without intermediate transhipment. The decline in the amount of fish dealt with through inland markets and the setting up of inland distribution depots by the larger merchants has changed the pattern of this traffic. The railway should concentrate on giving the trunk service from port to depot, leaving final distribution to individual customers in the hands of the merchants.

(5) *Livestock.* Some livestock (e.g., horses, cattle, sheep, etc.) requires the provision of a special vehicle. Much of this traffic has no regular pattern as it is destined for race meetings, shows, etc., and it varies in volume. Poor utilization of the specialized vehicles is often

the result. A very high standard of service is required, particularly where race-horses etc. are accompanied by attendants. This is difficult to give when the traffic is not in train loads, as often happens. Parcels-trains schedules may not give a satisfactory service, and at the same time those passenger services which are provided by multiple-unit trains are often unable to haul tail vehicles. The provision of a suitable service may involve the operator in considerable expense in special train working. This cost combined with the high expense of vehicle provision (a consequence of poor utilization), suggests that it is often not a particularly desirable traffic. Smaller livestock (e.g., dogs, pigeons, etc.) is usually conveyed in guards' brakes. Naturally, consignments of this kind require a little more attention than general parcels traffic.

(6) *Milk* is mainly conveyed in tank wagons. Individual wagons may do part of their journey by a passenger or parcel train but much of it is transported in train loads.

(7) *Vehicular traffic.* This traffic is mainly cars. (See page 215.)

(8) *Passengers' Luggage sent in advance of Travel.* This traffic is often suitable for making into through-van loads, thus avoiding intermediate handling and speeding up the transit. This opportunity should always be sought, in particular between resorts and the main centres of population, also between the latter and boarding schools, universities, etc.

(9) *Other traffic* including fruit, flowers and various perishables.

WORKING ARRANGEMENTS FOR PASSENGER-RATED TRAFFIC

How to reduce Sorting and Handling. To reduce the sorting and handling required for passenger-rated traffic, it is necessary to employ unit-loading methods to a high degree. Various types of containers, wire cages and stillages are in use. By reducing handling, the costs of operation are reduced and the speed of transfer increased.

Numerical Sorting Procedure. A method of marking general parcels with code numbers is in use on some regions. Each of the regions concerned is divided into zones, and each of these has a zonal centre. A parcel for any station within the zone is marked boldly with its zonal number at the sending point. The main parcels offices and many parcels vans have spaces set aside, each marked with the zonal numbers, so that the staff do not have to read the address labels. They merely read the zonal number on the parcel, and place it in the allocated space. It is not until the parcel reaches its zone centre that it is necessary to read the address label. This method speeds up sorting and enables it to be performed by staff with a limited geographical knowledge.

Transits of Passenger-rated Traffic. If the sender has considered it worth while to pay the higher rate for use of the passenger train service,

it is obvious he attaches some importance to a speedy transit. The main points to be watched to ensure that parcels transits are satisfactory are:

(*a*) Regular censuses and analyses of passenger-rated traffic should be made. Thorough examination of census details should be made before decisions are taken to modify or reconstruct the facilities for dealing with passenger-rated traffic at passenger stations. The census should show where the parcel is from, to, if part of a unit load, date of dispatch, and the service by which conveyed. These investigations will reveal: (i) if there is a further opportunity for through-loading, i.e., without intermediate handling; (ii) if more can be done with unit loading; (iii) any unsatisfactory features of the planned train service; (iv) where any delays have occurred in the transit of the particular traffic recorded.

(*b*) That traffic is dispatched promptly from the sending station.

(*c*) The main London terminii are dead-end stations and transfer between them is normally performed by cross-London cartage. Whenever possible passenger-rated traffic should be routed to avoid cross-London cartage and the delay that this involves.

(*d*) That traffic is not delayed at points where it is transferred from one train to another.

(*e*) That traffic is not being delayed on account of inadequate brake space in multiple-units or other trains.

(*f*) That delay is not resulting from the wrong loading of traffic or on account of its being carried beyond its destination.

(*g*) That traffic is not being delayed at the destination station because of shortcomings in the cartage arrangements. Cartage workings should be re-appraised frequently to ensure that they are maintained at an efficient level in spite of variations in traffic flows.

SUMMARY

1. *High speeds are necessary to win traffic and to cut costs.*
2. *They cannot be obtained if there are many intermediate stops.*
3. *A frequent service is consistent with good utilization of operating units.*
4. *Regular interval services are beneficial to passengers and the operator.*
5. *Maximum through services should be provided by analysing traffic flows.*
6. *There should be a seat for every passenger on long journeys.*
7. *Stopping-train mileage should be reduced.*
8. *Much of the cost of dealing with general parcels traffic is absorbed at stations. Sorting and documentation should be reduced to a minimum.*
9. *Fast transits should be secured in a scientific manner by through loading in unit loads, where possible, on services based on regular analyses.*

CHAPTER 14

Punctuality of Passenger Trains

ONE hears it said of the Italian dictator, Mussolini, " at least he made the trains run to time." If this was so, which is doubtful (it was probably some of the trains, some of the time), it was no mean accomplishment. Railways are particularly susceptible to bad punctuality for a number of reasons. In the first place, they are track-bound. The inability of a unit to overtake readily a preceding unit which has stopped or is moving slowly, is a cause of much consequential delay.

Secondly, the absolute block method of signalling is very restrictive. In the planning of the train service, as we have seen, this is taken into account, but if there is deviation from the plan for any reason, the confining of one train to one section frequently results in delay. These two factors—being track-bound and the restraints of the signalling system—do create an interdependence between trains. This may result in a small delay at one point, accumulating larger delays over a wide area and delaying other trains hundreds of miles away. It is particularly noticeable on British Railways with its high traffic density, its numerous flat junctions, and its complicated pattern of country-wide connecting services. Waiting for late connectional trains is another contributory factor to the " snow-ball " effect of delays, to which we shall give consideration at a later stage. This relationship between one train and another, and the tendency of accumulative delay greatly to exceed the original loss of time, makes it imperative to avoid any unnecessary hold-ups, however small. It also calls for a very high standard of teamwork, among the railway staff of many departments and over a wide area.

Thirdly, speed is an important attribute of rail passenger transport. In relation to road competition this may be a selling point. In consequence, the rail operator tends to schedule his services nearer to the maximum speed capacity of his motive power than the road passenger operator. The latter is obliged by legislation to limit the speed of his schedules. In the event of time being lost by his vehicles for any reason, it can often be recovered. Should this legislation be repealed, and the road operator be free to schedule his services without restriction, there is no doubt that many schedules would be accelerated. This would have some advantages for operator and passengers alike, but it would

not be surprising if it had a slightly adverse effect on the punctuality of the service concerned.

The inherent difficulties outlined above in running trains punctually are no concern of the passenger. Many travellers attach more importance to reliability than to speed, because this enables them to plan ahead with confidence. It is the task of the railway to supply services which can be relied upon, otherwise it is in danger of losing custom to more reliable forms of transport.

PLANNING FOR PUNCTUALITY

The first step is adequate and accurate planning. The preparation of the timetable is only a part, but an important part, of this plan.

Running Allowances

The plan must be preceded by the establishment of point-to-point running times, according to the type of motive power which is to be allocated to the train and the weight of the load. Already it has been said that these times are often related closely to the speed capacity of the motive-power unit. There does not appear to be any merit in having a vast potential of power which is hardly ever exploited. On the other hand, if the railway is to provide a reliable service, the point-to-point timings must be capable of regular performance in reasonably adverse circumstances. It would be unwise to establish timings which can only be sustained by the best driver with the best locomotive in ideal weather conditions. They must be capable of fulfilment on a wet evening in November as well as during a dry midsummer day. The timings must have regard to the permanent speed restrictions in operation, and thereby eliminate these as potential causes of lost time.

Temporary speed restrictions, which may last only a few hours or may operate for a few weeks, present more complex problems. In the interests of punctuality the minimum restrictions should be imposed, the maximum speeds which safety permits should be allowed, and the restriction should last for the minimum time. The Civil Engineer knows in advance when those caused by his maintenance and renewal work are likely to be imposed and when they can be withdrawn. Similarly, he is able to calculate the length of track over which the restriction is required to operate and the maximum speed to be permitted. The operator must try to establish what loss of time this may represent for each type of train. It is then necessary in the interests of punctuality, to balance the work as evenly as possible throughout the duration of a particular timetable. The arrangement of work which is most convenient and economical to the engineer is not often in the best interests of punctuality. Making the compromise is a difficult task, particularly

when the early completion of the engineering work is vital to improve or maintain the speed of running. The operator must discourage the engineer from imposing these restrictions at a time when peak traffics are likely to pass.

For example, the effects of a restriction on an important line to a seaside resort may be small in the winter months, but serious in the summer. In the winter months the restriction may only retard the trains affected by a few minutes. On peak days in the summer, the necessity for trains to reduce speed in observing the speed restriction may reduce the capacity of the line below the level required. If the effect of the restriction is not properly taken into account in planning, and trains are booked in excess of the capacity of the line, delay is inevitable and may be widespread.

Work on the track is retarded when it has to be performed between trains, and this extends the time the speed restriction is in operation. It is often beneficial to both parties if arrangements can be made for the engineer to have complete possession of a line or section of line at some mutually convenient time to speed up the process. During the total time of the engineer's possession, reorganization of train services, including diversion of trains over other routes, and substitution of road services in place of train services, may be required. This calls for a major planning operation. Some delays to passengers and freight during the time of the possession are inevitable but careful and skilled adjustments prepared in advance, can reduce these to a minimum.

When diversions are arranged, the engineer should take the opportunity to do any other work he can on other sections within the limits of the line from which traffic has been diverted. Before the event, efforts should be made to advise passengers through the most suitable medium of communication of the revised duration of journeys during the possession. Complete possessions may result in quite serious delays, but at least they are confined to a short period. If it has been possible to communicate to the passenger in advance the extent of the likely delay and the reason for it, the inconvenience caused will be reduced and goodwill maintained. This may well be preferable to the situation which arises when engineering work is retarded on account of being done between trains. The delay this causes may be smaller per train but is extended over a longer period.

When agreement has been reached with the engineer on the extent of the work to be done over a period of time and the effect this is likely to have on train running, a suitable allowance known as recovery time should be incorporated in the timetable. The amount of recovery time should relate to the cost, in time, of the speed restrictions and it should

be allowed at the point in the schedule where the restriction is to be imposed. The difficulty in doing this is that, if the period of time covered by the timetable is rather long, the engineering work—and therefore the restrictions—will move from place to place. To allow for this, in planning a service, the line would normally be divided into sections. Engineering work within the particular divisions would be planned, and any recovery time allowed within a section should cover the loss of time likely to be brought about by such work. The shorter these sections are, the more effective recovery allowances are likely to be.

EXAMPLE. A line 200 miles long is divided into 50-mile sections for this purpose, and 10 minutes recovery time—covering two or three operations—is required in a particular section. It is difficult to apportion that 10 minutes within the 50 miles. If there is an intermediate station at which some trains stop, should the recovery time be to the rear of it, in advance, or divided between the two? In these circumstances the engineer would be justified in performing his work at any points within the 50 miles. If instead, the line can be split up into 20-mile sections for this purpose, the operator's problems are lessened. The recovery time is assured of being fairly close to the site of the speed restriction. The engineer suffers more restrictive conditions, with 20-mile sections, instead of 50-mile sections, which may have adverse effects on his work.

The severity of the restrictions is also likely to vary over a period of time. Should we plan for the maximum restrictions, or the minimum or something in between? If we are determined to achieve the best timekeeping, plans must be based on the maximum restrictions that are likely to apply. Outside the period when maximum restrictions are in effect, schedules worked out in this manner are slower than is necessary. It has already been established that this may reduce line capacity and increase working costs.

If one is planning some time ahead, and it is shown in Chapter 9 that this is necessary, events may upset the phasing of the engineering work. If engineering work on a large scale is necessary on a particular line, it is desirable in the interests of punctual working to reissue the timetables at frequent intervals to enable the difficulties which have been listed to be reduced. The system of one timetable for the four summer months, and another for the eight winter months is not conducive to satisfactory results in these circumstances. On the other hand, frequent alterations to the timetable are not welcomed by passengers. This pill may be sweetened by making a free issue to passengers of train-service details in advance of the alterations being introduced.

Before leaving the question of the relationship between speed restrictions and punctuality, it must be recognized that not all permanent-way

cautions come about in consequence of engineering work arranged in advance. The discovery of a defect in an under-line bridge, a sudden deterioration in the foundation or in the track, or other causes can necessitate an emergency restriction on speed being imposed. To allow for this kind of eventuality, extra recovery time to cover such contingencies may be included. This will cushion the effects of restrictions, which have not been anticipated, on punctuality. It will have the disadvantage of slower journeys for the passenger, and extra expense in the provision of the service. *Speed is economical;* this, it may be recalled, was our second principle of operation.

Recovery time should be distinguished in the working timetable from ordinary running allowances. This is beneficial to drivers and should help them to keep on schedule. It is also important that signalmen should be aware of the possibility of late-running trains recovering several minutes, where there is recovery time allowed but no speed restriction actually in operation at that point.

Station Allowances

To conform to the first principle, that of maintaining movement, trains which are required to stop at intermediate stations should remain at rest for the minimum amount of time commensurate with the duties to be performed. If this allowance is inadequate, punctuality cannot be maintained. One complication is that the number of passengers joining and alighting and the number of parcels, luggage, etc. to be loaded and off-loaded vary from day to day. The station staff, who attend the train, vary in their speed of working. It is not possible to allow for the day to day changes, and it is necessary that the time a train is booked at a station should be adequate on a reasonably busy day. Adjustments can be made for long-term changes in traffic flows, which are a feature of railway working. If the number of passengers and parcels to be dealt with substantially changes, making an existing station allowance too short or too long, an alteration should be made. Station masters and other station staff who are closest to operations should be made responsible for making recommendations prior to planning being commenced in the Timing Office. The recommendations should be based not only on recent traffic changes but also on anticipated trends; e.g., the opening of a factory near the station might justify increased allowances.

There are some seasonal traffic changes which may be catered for by temporary re-timings. This is desirable if seasonal traffic is not to be permitted to upset timekeeping every time it arises. It is not satisfactory for a train to be allocated an unnecessarily long station allowance for eleven months of the year, to provide for traffic passing during one month only. That inadequate station allowances may result in bad time-

keeping is apparent. It is not so obvious that excessive allowances may also lead to delay, but this does happen.

EXAMPLE. An express train is running ten minutes late. It arrives at a station where it has an allowance of eight minutes, but it only needs three minutes. Therefore it departs only five minutes late. A signalman at a block post just ahead of the station is obliged to regulate preceding trains some time ahead and is working, therefore, on a basis of the express being ten minutes late. Therefore, when the express is ready to enter the section ahead of his box, it may not do so because another train has been permitted to precede it and is still in the section. It is brought to a stand at the signal controlling the entrance to the section. By the time the express is ten minutes late again, the previous train has cleared and the express may continue. Because it has come to rest at an unscheduled place, it takes several minutes (say three) to resume its booked speed. Therefore, it has now become 13 minutes late instead of ten minutes. One cannot lay any blame on the station staff, who recovered lost time; indeed, later it will be emphasized that they should try to make this recovery. The signalman also acted correctly in permitting the other train to go in front when there appeared to be an adequate margin. The error lies in incorrect planning which gave excessive time at the station.

MAKING THE PLAN REALISTIC

Giving proper running and station allowances in making the plan of operation plays an important part in good timekeeping. Apart from these items, it is plain that the plan must be realistic if the trains are to adhere to it rigidly. If any attempt is made to overburden the line capacity, late running must result. Some line capacity should be left spare for the performance of unscheduled movements and to absorb the effects of slight deviations from schedule. This will avoid such deviations setting up a whole series of delays to other trains. This is an important consideration in the preparation of a timetable, and also when adding special trains to it from day to day. If enthusiasm to keep mobile equipment on the move is permitted to lead to the scheduling of turn-rounds of equipment or train crews which are not capable of fulfilment, this must also have similar consequences. At the same time it is an unsatisfactory solution to inflate turn-round allowances to a level which increases costs, to compensate for unreliable timekeeping of incoming trains. This answer glosses over the fundamental problem—which is to solve the late running itself.

Careful cross-checking of the many parts of the plan is important. The engine diagrams, the carriage rosters, the platform workings and the timetable are each dependent upon the other. For example, the power of the diagrammed engine must be adequate to pull the number of coaches which are scheduled, and all stations must be capable of dealing with the train in the times indicated.

Passenger Train Loadings

This brings us to a most important point in regard to locomotive-hauled trains. Far too often passenger trains convey too many vehicles. The transport operator gets no payment for empty seats. With passenger-train services, the conveyance of too many vehicles on locomotive-hauled trains is not only wasteful, it makes good timekeeping more difficult to attain. (1) It may involve drawing up at short platforms. (2) Time is more likely to be lost by the locomotive with a large train load, particularly where there are severe gradients. (3) With a small load, a driver may be able to regain time that has been lost through other causes.

Periodical checks (passenger censuses) are necessary to ascertain if the seating capacity of a train is being fully used. If not, the possibility of reducing the number of vehicles conveyed should be investigated. One of the principles of operation was that, operating units in excess of requirements are expensive and lead to inefficient operation. In this case the cost is in extra fuel consumption by the locomotive and in unnecessary carriage cleaning. The inefficient operation means bad timekeeping. Where time is being lost by heavy loads or where it is important to give drivers a chance to recover lost time and most seats are being used, it is still possible in some cases to reduce the load of the train without reducing the number of seats. This may be done by varying the ratio of first- and second-class seats, by reducing brake-van space, or by using stock with a higher seating capacity. It may be recalled that in Chapter 4 the seating capacity of compartment and open stock was compared.

Connectional Margins

In building up the national network of passenger trains it is not advisable to create an unnecessary degree of dependence in relation to timekeeping between one train and another. Connections should only be scheduled where they are likely to be well used. A regular scrutiny should be undertaken of the use made of existing connections. If the connections are not well patronized it may be desirable for them to be severed when the timetable is reissued, to avoid the unpunctuality of one train reacting on another. At stations where trains interconnect, part of the plan of operation should be a clear guidance to the staff concerned how long, if at all, a train may be held for a connection. The preparation of these arrangements calls for careful attention to:

(1) The convenience of the passengers. It may be necessary to give more weight to majorities than to minorities, or to long-distance passengers over casual short-distance passengers, etc.

(2) The likely effects of detention of trains on platform workings.

(3) The effects of detention on subsequent trains formed by the motive-power unit, train crew or coaching stock of the train being held.

(4) The effects of the late running of the detained train on other trains over the same route.

With the interdependence of the various aspects of operating work in mind, the minimum detention of trains for connectional purposes is a good aim, provided that the interests of the passengers are borne in mind. If connections are severed in achieving this objective it may be necessary to make special arrangements for the conveyance of passengers whose scheduled service has been interrupted. This may consist of the provision of special road transport or a special train. In both cases advance planning is usually the best way of ensuring that the passenger who has already been delayed should not suffer further delay. Sometimes it is possible to reduce time already lost, by enterprising planning or by the use of initiative.

CARRYING OUT THE PLAN TO ACHIEVE PUNCTUAL WORKING

However good the plan and regardless of the effort that has gone into it to ensure that it is capable of being fulfilled, a large measure of responsibility for its ultimate success must rest with the people who are responsible for its execution. The drivers, station masters, signalmen, station staff and other grades all have an important part to play. The failure of any one of them can undo the plan and spread delay. Particular onus rests upon station masters and other depot masters. On receipt of that part of the plan that concerns their depot it should be checked. It is not practicable for everyone to be supplied with proofs of the plan. The people most concerned should be, and their corrections to the proof should be incorporated in the final work.

Responsibility rests on all to see that the plan is workable and comprehensive. Errors and omissions should be pointed out and rectified before the plan comes into operation. A mistake by a planning clerk should not result in delay, because people closer to the scene of operation in district office, control office, station or depot should keep a look-out for this kind of possibility. The shed master and station master must also ensure that each member of their staff concerned has received that part of the plan which concerns him, and that each individual understands what contribution is required from him. There must be clear definition of responsibility not only as to which train a porter must attend, but also which part of the train, whether he is to close doors or load parcels, or both.

Making a Punctual Start

Prompt starts are an important beginning to good timekeeping. This involves getting the train ready to leave at the appointed time and getting the passengers and any other traffic loaded into the train before the appointed time. The former depends on the efficiency of the plan and also on a careful watch being kept on its evolution. The plan for the 7.0 a.m. suburban train may be correct in all detail but Guard Smith may be knocked off his bicycle on his way to work at 6.10 a.m. and be unable to report for duty. It is vital that his absence should be detected and alternative arrangements made in sufficient time to enable the train to leave punctually. At large stations and key points spare men may be booked on duty to cover incidents of this kind. At smaller depots this would not be justified economically, and it is advantageous to have other platform staff trained in guards' duties and with the necessary route knowledge to take over in emergencies. In circumstances like this, the Control organization may prove invaluable. The trainmen's controller, who should be familiar with the location and duties of all guards at the particular time, may be able to make adjustments to cover the absentee's duties without delay to any trains.

Proper liaison and good communications between signalmen and staff are important in achieving punctual starts, particularly when events demand some adjustment of the normal routine.

Getting the passengers into the train for the appointed time can best be achieved by getting their co-operation, but a little applied psychology also helps. Some station masters have found it advantageous to have those clocks which face outwards from the station a couple of minutes fast! Once the passenger is in the station he must be helped by:

(1) Not being delayed at the booking office. The expeditious handling of queues at booking-office windows is often capable of solution without incurring much, or sometimes any, additional expense.

(2) Being given clear directions of the location of his train.

(3) Having his walking distance reduced to the minimum.

(4) Being permitted to reach his train without interruptions.

How these things can be done has been set out in Chapter 6. To ensure a punctual start and to avoid accidents to passengers who arrive late and who might attempt to board moving trains, it is desirable to forbid entry to the platform from a few seconds before the train leaves. For this purpose, passenger barriers are provided at some places.

A small factor, but an important one, because it applies at all stations at which the train stops as well as at the starting point, is time

lost in the exchange of signals when the train is ready to depart. The first is normally a signal to the guard by the person in charge of the platform that station duties are completed. The second is the message of the guard to the driver that the train may start providing the signals permit. Hand signals, and signals with flags or lamps, may be obscured by people on the platform or by escaping steam from the train heating system or from a steam locomotive. Moreover, they may not be acted upon immediately, because of inattention on the part of the person for whom the signal is intended. Supplementing visual signals by audible signals or using audible signals instead often proves beneficial. The use of a whistle not only alerts staff to prepare for departure; it has the same effect on passengers. On certain Regions multiple-unit train guards give the "right away" signal to the driver by bell or buzzer instead of by visual signals. Proper attention to heating apparatus to avoid leaks, and the placing of staff along the platform to pass signals along helps to eliminate delays from the causes mentioned.

Clear Signals

The driver must be helped to maintain punctual running by having clear signals as far as possible. The signalman in his cabin some distance from his distant signal does not always appreciate that the driver, seeing a distant signal at caution, may need to make brake applications. Thereby the train may lose minutes, although the stop signals may be pulled off by the time the train reaches them and it may pass the signal-box at a reasonable speed. Signalmen must be helped to realize this and must make greater efforts to ensure clear signals. One increasing problem is at level crossings. Because of the out-moded methods used at many level crossings in Great Britain, delays to road traffic waiting the passage of trains is considerable. Some motorists, unfairly but perhaps understandably, vent their wrath on the nearest railwayman, who is the signalman operating the crossing gates or barriers, or perhaps the crossing keeper. If the railwayman sometimes anticipates this, and permits road traffic to pass later than he should, this may result in distant signals being kept at caution a little too long, and trains being delayed.

If some signalmen do not appreciate the effect on punctuality of distant signals being seen by the driver while at caution, likewise there are some drivers, who have too little understanding of signalling. They imagine that distant signals at caution are almost invariably the consequence of negligence or bad working on the part of the signalmen. The effect on a driver's morale of this kind of belief can only be harmful. There is a danger that he may relax his own efforts to maintain strict punctuality or to regain time lost, because he believes others are

not playing their part. There is a need to achieve a better understanding of the other man's problem on the part of both train crews and signalmen. It is an educational problem worthy of some attention. Where automatic signalling is in operation the driver has a better appreciation of the reason why he does not always get clear signals. This stems from automatic signals having a normal OFF position and non-automatic signals having a normal ON aspect.

Much signal delay is the result of drivers exceeding their point-to-point running times. This applies most with steam locomotives, where a great deal depends on the judgment of drivers. This is not so important with diesels, and even less with electric traction where acceleration is more automatic. This largely explains why punctuality results are usually superior on lines with electric traction. In all cases where running allowances are exceeded it is important that the driver should be made aware of it at the first opportunity.

Train Regulation

When there has been deviation from the advance plan, signalmen are called upon to regulate trains according to priorities. To do this, a signalman, before permitting a train to precede a more important one, must calculate how long the first train will take to pass over and clear the common track which the two trains must share. This is known as a margin, and is based on point-to-point running times, plus allowances for any stops. It must also take into account any late running on the part of the second train and if it is likely to recover any of the lost time before reaching the common track. The first train must have sufficient margin to clear the common track without causing delay to the second train. If: (*a*) the signalman miscalculates the margin; or (*b*) permits the train to leave without a proper margin; or (*c*) the driver of the first train exceeds the margin, delay to the second may result.

Conversely, it would be bad operating practice to fail to take opportunity of a margin where one existed because this would involve holding the first train until after the second one had passed, when in fact the first could have taken precedence without delay to either. The signalman called upon to regulate trains in this manner must be fed with information regarding the actual timekeeping of trains approaching him. To save the time of all concerned, he should be supplied only with the minimum information necessary to enable him to do his job. It is preferable for the information to be passed direct from signal-box to signal-box, and not to be relayed via the Control office. These advices, known as Train Reports, are quite separate from the details supplied to the Control office for their use. Instructions are laid down stating which boxes are required to pass on information regarding

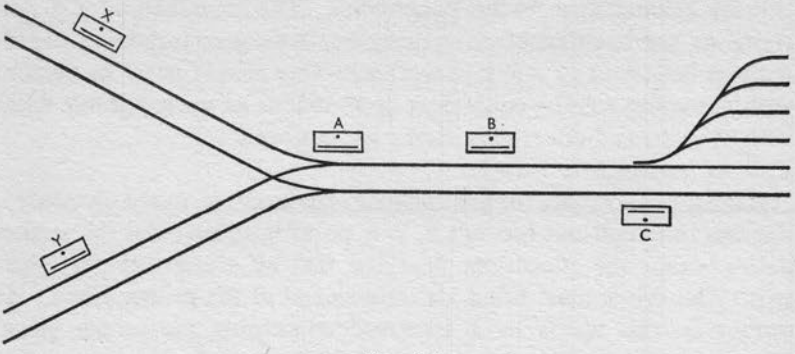


FIG. 14.

train running, and setting out to which boxes the information should be communicated. On lines supervised by a Control office, a close liaison between the signalman and control produces the best regulation. In Chapter 10 this relationship is discussed in more detail.

EXAMPLE. In Fig. 14 the signalman at *A* has a late-running freight from *X* to the marshalling yard at *C* offered to him. He accepts it and it enters the section at *X* at 10.0 a.m. An express passenger train from *Y* to *C* is due to pass *A* at 10.25 a.m. and *B* at 10.30 a.m. The report received at *A* tells him the express is running on time. Can *A* permit the freight train to go first? From the point-to-point running times he ascertains that the freight needs

X to *A*	6 minutes
A to *B*	7 minutes
B to C	7 minutes
Plus an allowance for deceleration on approaching and entering the yard at *C* ...	3 minutes
Total	23 minutes

Therefore, arrival time at *C* = 10.23 a.m.

As the express is not due to pass *A* until 10.25 a.m. when the freight train should have been inside the yard at *C* for two minutes, there is a margin for the freight train in front. Bearing in mind that the distant signal for the *B*-*C* section is between *A* and *B*, it will be realized that had the freight train been five minutes late (i.e. arriving *C* at 10.28 a.m.) the express could still have left *B* at 10.30 a.m. (on schedule) as far as the block working is concerned. In this event, however, the driver of the express may have seen *B*'s distant signal at caution and been obliged to apply his brakes. The loss of time involved by this might have prevented the train passing *B* at 10.30 a.m.

Existing signalling lay-outs should be reviewed from time to time, to ensure that they are designed to give the greatest facility of movement,

thereby helping to maintain punctuality. The introduction of a new signal or the re-siting of an existing one may give surprising benefit without detriment to safety in working. One should never be content with accepting existing equipment or situations as unchangeable when with thought and effort they might be improved.

Calls at Intermediate Stations

If the time allowance for intermediate calls has been, as recommended, not too little and not too much, it is possible to perform the station duties within the allocation, provided that all concerned play their part. The driver must bring his train to rest at the proper place. He cannot do this unless he is informed concerning the proper place. Signs placed appropriately on the platform, indicating the point opposite which the driver's cab should halt according to the number of vehicles on the train, are helpful. Knowing that the trains will come to a halt at fixed points, the station staff can then stand in the proper positions before the train arrives; porters to assist passengers to alight and help them with luggage; parcels porters with empty barrows for parcels, etc. to be off-loaded, and with loaded barrows with goods for forwarding will stand opposite the position where the appropriate brake vans will stop. Fixed train formations are essential for this to work successfully. At small stations where possibly only one or two men are on duty, the best part of the platform for them to stand before the train arrives can only be decided according to circumstances. Prior intimation of the arrival of trains must be arranged to permit staff to break off from other duties and line up for train arrivals.

The detraining of passengers quickly is facilitated if they are made aware that the train is approaching their destination or transfer point. It is advantageous to have a passenger-address system on the train, to permit the guard or other member of the train crew to make any necessary announcement. A line-side sign indicating that the train is approaching a station (e.g., *Z* station—1 mile) is likely to catch the eye of at least some of the people who intend to alight. If all the passengers have not been alerted to prepare to detrain before the station is reached, no time should be wasted on arrival in announcing the fact both visually and audibly. Adequate exhibition of the station name and reasonable lighting are both important. Where there are public-address systems these should be used, except possibly during the night hours when the train is conveying passengers in sleeping cars.

At smaller stations where a public-address system is not justified, and where fairly long trains prevent verbal announcements being heard throughout immediately, a portable transistorized amplifier worked from a battery may help. These amplifiers are quite cheap and

are useful in other aspects of operating work. Rapid loading and unloading of passengers is dependent on an adequate number of doors. Apart from the speed of entraining and detraining, there are other considerations to be taken into account in determining the number and type of doors to be fitted in coaches. These are mentioned in Chapter 4. The closing of carriage doors is often performed by the passengers themselves after they have boarded the train or alighted from it; this is a valuable help in maintaining punctual working and it should be encouraged. This is a further illustration that the co-operation of the passenger has to be sought if punctual running is to be achieved.

Parcels traffic to and from intermediate stations may be prohibited or restricted on certain trains, in the interests of punctuality. If there were no other considerations but punctuality, the banning of parcels from passenger trains would be beneficial. In Chapter 13, however, it has been pointed out that this may increase the cost of conveyance and also extend the transit time of the parcels. It is necessary to weigh the various considerations against each other. When parcels etc. are permitted there are a number of steps which can be taken to avoid delay.

Here are a few suggestions:

(*a*) When a station is forwarding an unusual number of consignments or particularly heavy individual consignments for an intermediate station (or for the destination station where a quick turn-round is scheduled) the sending station should advise the destination station of details. This may enable special arrangements to be made at the unloading station to deal with the abnormal traffic in the normal time allowance. A similar advice is also necessary if special vehicles are conveyed by the train for detaching intermediately. In this case the vehicle should, if possible, be marshalled on the train in a position which will enable it to be detached with the minimum of delay to the train. Delay may be caused when vehicles have to be conveyed on trains and detached intermediately, not according to any regular pattern, and it may be worth while to look for an alternative means of dealing with the traffic.

(*b*) If the sorting of parcels during off-loading is likely to cause delay this should be done after the train has left.

(*c*) If the loading up of forwarded traffic is likely to cause a late departure or to prevent time being recovered on a late-running train, consideration should be given to leaving it off and forwarding by a later train, or by road service, whichever is appropriate. One has to take into account the effect that such action is likely to have on the transits of the parcels.

EXAMPLE. At 6.0 p.m. one evening, station *A* has 40 parcels for delivery at station *B*, 50 miles away. To load these on to the 6.5 p.m. train would cause it to be delayed. There are other trains at 8.5 p.m. and 10.5 p.m. The delivery vehicle at *B* does not go on its rounds until 7.30 a.m. the next morning. In this case there is nothing to be gained by delaying the 6.5 p.m. train. If the same situation arises at 6.0 a.m. there is a case to be argued for putting the parcels on the 6.5 a.m. train, at the price of a late departure, as the next train at 8.5 a.m. will be too late to ensure the parcels being delivered that morning.

One must have regard to the real transits of the parcels. Traffic which is to be called for at the destination station by the consignee, frequently has an urgency which delivered traffic does not. To reduce interference with good timekeeping to a minimum, and with proper regard to providing quick transits for parcels, the sorting of traffic according to its urgency must be done prior to the train's arrival. This will ensure that the urgent traffic is loaded first, and if traffic is left off, it will be that which can be left behind without detriment. To work in this manner calls for education of the staff on the method of working at other stations and on the relative urgencies of different traffics.

(*d*) Careful loading of brake vans at starting points, which segregates traffic for off-loading at the various stations, is of vital importance. It should never be necessary to search for traffic to be discharged at an intermediate station.

(*e*) To maintain this segregation the guard may be required to sort, between stations, any parcels which are put in at intermediate stations, where time does not permit sorting at loading point. He can also help by moving traffic for unloading close to the door before the train reaches the station.

(*f*) Traffic may be loaded and unloaded more expeditiously if the right type of vehicle with adequate doors is used. Segregation cannot be performed unless there is adequate space for the traffic.

At stations, where the platforms are not sufficiently long to contain the whole length of a train, delay may be caused by the trains drawing up. This may be obviated by:

(1) Lengthening the platforms. This is an expensive solution only justified in certain cases.

(2) Shortening the length of the trains.

(3) Directing the passengers who wish to alight, to that particular part of the train which will be halted alongside the platform. The direction may be given by the guard, ticket collector or other member of the train crew, by labelling the coaches, by notices on platforms or by loud-speaker. The van for loading and unloading traffic must also be in the portion of the train that stops alongside the platform.

Finally, with regard to intermediate stops, it is worth while to mention that trains should only stop at stations at which they are scheduled to stop. Applications are received from time to time for trains to be stopped specially at other stations. Unless these applications are resisted as much as possible, punctuality is bound to suffer.

Time Lost by Incidents

For reasons previously outlined, incidents, such as a door coming open on a passenger train, or a defect arising on a vehicle, frequently cause severe delays. The operator must strive constantly to reduce these to a minimum. Sometimes it is within his power to reduce the number of incidents. The proper spacing of porters on platforms, particularly having a man stationed at the front, can reduce incidents caused by open doors. Frequently, the cause of the incident is the responsibility of another department. Point failures, signal failures, rolling-stock defects and many other happenings fall into this category. In these cases the operator has still an important part to play. With the co-operation of the department concerned he must seek to avoid further similar incidents or, if this is not possible, he must satisfy himself that the arrangements for rectifying the fault and the emergency arrangements during its existence are the best that can be devised to minimize the ill effects on timekeeping.

With all the hindrances to good timekeeping so far reviewed, there has been in each case some kind of action which could be taken to improve matters. There are a number of circumstances which cannot be avoided, but even in these cases there is scope for the best operating methods to be applied to reduce the adverse effects on timekeeping. In fog, better punctuality can be maintained if it is recognized that drivers searching for signals will need to travel more slowly, and if the number of trains is reduced according to the diminished capacity of the line which results from slower train speeds. A reduced programme of trains to operate during fog, sometimes called a " fog service," is better prepared in advance than one extemporized after the fog descends. Naturally, colour-light signals, automatic warning systems, and the prompt provision of fogmen at semaphore signals, all help trains to run closer to schedule when visibility is bad.

When delay has occurred and a train is running late this need not result in unpunctual journeys for all passengers *en route*. Arrangements should be made where circumstances permit for a special train to be introduced farther along the line of route in the times which the delayed train should have occupied. This can often mitigate the effects of the original delay to a large degree.

Team-work within the operating department and with other depart-

ments is necessary to run a punctual train service. The promotion of an interest in, and enthusiasm for punctual working in all staff is an important management responsibility. Payment by punctuality results, if a satisfactory scheme could be devised, would almost certainly bring about improvements. Working out a bonus method of payment which would be a real incentive to the staff, which would not prejudice safety in working, and which would be comprehensible and acceptable to the men concerned, is an immense task. In the absence of a punctuality bonus, interest must be sustained by any means available. Competitions between regions, between districts, between lines, even between different shifts at a station, are all methods which have been tried at some time. Punctuality " drives," which involve concentrating extra supervision on this matter and giving it special publicity, have proved beneficial. These " drives " throw a spotlight on defects in the plan which may not have been revealed by other means. They often produce a much higher norm (i.e., a standard) for the period they cover, against which subsequent results may be measured.

Punctuality is difficult to achieve on railways but there is plenty of scope for improvement. It can only be accomplished with the continual help of other departments. It can only be maintained by an efficient, enterprising and enthusiastic operating staff working together as a team. Much depends on supervision. Results deteriorate when supervision relaxes. The poorest performance is often put up when traffic is light and there is the least excuse for being late, such as during the evening or during the night. This results from a relaxation in supervision. The rewards, in standard of service to the customer and in cutting the operator's costs, are worth striving for constantly.

SUMMARY

1. *Reliability is vital to customer and operator alike.*
2. *Realistic planning is the basis of good timekeeping. Don't promise more than you can perform.*
3. *It is better to run* 95 *trains punctually than* 100 *late. Don't overtax line capacity.*
4. *The responsibility for sound planning is not confined to the planning offices. All operating staff have a part to play.*
5. *Start right with a prompt departure.*
6. *Clear signals are important.*
7. *Get the passenger's co-operation. Reward him with a punctual arrival.*
8. *Reduce incidents to a minimum.*
9. *Punctuality depends on teamwork.*

CHAPTER 15

Statistics

DISRAELI once said, " There are three kinds of lies. Lies, damned lies and statistics." Most of us have been in sympathy with that remark at some time or other. It is commonplace for someone who does not understand the statistics at his disposal to lead himself to erroneous conclusions from them. Sometimes, one hears them used by people who do understand them to others who do not, in an effort to persuade the listeners that inferences can be drawn from them which would not be justified if the statistics were not misused.

With statistics therefore we are dealing with something that is dangerous unless properly used. Yet one cannot run a large business without them, and they are particularly valuable in railway operation where the units of production are dispersed over a wide area. In previous chapters the importance of scientific planning has been stressed. Efficiency cannot result where management decisions are founded on impressions. Therefore, the operator must have statistics and it is important that he should have a thorough understanding of them. This chapter can only touch briefly on operating statistics, as they constitute a subject worthy of a book in themselves.

Operating statistics are enumerations or estimates of happenings systematically collected and arranged to show their relationships.

PURPOSE OF STATISTICS IN RAILWAY OPERATION

Statistics are a tool of management. They should be employed to achieve a given aim and never be permitted to become an end in themselves. The main purposes are:

(*A*) To assess the volume of work done or the receipts for doing it.

(*B*) To assess the effort or cost expended to do the work.

(*C*) To measure efficiency. This may be expressed as a relationship between (*A*) and (*B*), or the statistics may show the quality of the service which has been provided.

(*D*) To show trends.

(*A*) *Assessing Volume of Work Done or Receipts for doing it.*

From this point of view the essential thing is how much were the gross receipts from any particular activity. Unfortunately, variations in rates and charges reduce the usefulness of these figures from the

point of view of the operator. Therefore, it is desirable to supplement them by details of traffic carried and the distances which it was conveyed. Examples are given in paragraphs *A* (1) to *A* (7).

A (1) *Passenger journeys originating.* This is calculated from the number of tickets issued. Single tickets are counted as one journey, returns as two. The number of journeys by season-ticket holders is computed in a statistical period by assessing the period covered by each season ticket on a basis of 600 journeys per annum. (This is the first example of the use of estimates which were mentioned in the definition of *Operating statistics.*)

A (2) *Passenger miles.* The number of passenger journeys originating gives a picture of the work done at passenger stations, but does not give a reliable guide to the use made of the transport provided, as it counts the passenger who travels four miles equally with the passenger who travels 400. Therefore, the passenger-mile figure is required to take distance into account as well as the number of people travelling.

A (3) *Passenger receipts.* This is an even more important figure, but variations brought about by commercial activities, such as adjustments to fare levels, reduce its value to the operator unless allowances are made for such changes. It is also affected by variations in first- and second-class travel. Separate totals should be prepared for the main types of ticket; e.g., full fares, reduced fares, season tickets, etc.

A (4) *Freight-train traffic originating.* This needs dividing between private sidings and terminals, if it is to give a useful guide to the activities of the latter. It must be subdivided into commodities as it will be readily appreciated that different types of freight involve the railway in varying amounts of work and bring different revenues.

A (5) *Net ton miles.* This is a better figure than traffic originating as it expresses the distance conveyed as well as the amount of traffic. Again, it needs dividing if conclusions are to be drawn from it, as there may be gains in mineral traffic but losses in merchandise traffic.

A (6) *Freight-traffic receipts.* This is an important figure which should be divided between merchandise, minerals, coal and coke, livestock and parcels, etc., by passenger train if it is to be useful. In comparing two periods one must guard against being misled by variations in charges which may have occurred.

A (7) *Total receipts.* Calculated by adding any miscellaneous receipts to *A* (3) Passenger Receipts and *A* (6) Freight Receipts.

(*B*) *Assessing the Effort Expended to do the Work, or the Cost of Doing it.*

It is the cost of earning the receipts which really matters, but alterations in wage rates and in the cost of equipment affect this figure. The operator may profitably use other statistics which show the number of

units of operation employed and the use made of them to measure operating efficiency in a particular direction. See examples below.

B (1) *Number of staff employed.* As substantially more than a half of working expenses are absorbed by payments of wages and salaries this is obviously an important figure. It does not reflect the amount of overtime worked and paid for, therefore one also needs:

B (2) *Working costs for salaries and wages.* In making comparisons with other periods this may not be as useful as the number of staff employed, as the figure is affected by variations in rates of pay. In regard to both *B* (1) and *B* (2) a break-down is often required according to the grades of the people employed.

B (3) *Total operating stock of locomotives.* As the proportion of electric and diesel locomotives increases and as the number of steam locomotives decreases, so the total required to do a fixed amount of work should be reduced, owing to their greater availability. The figure should also be reduced as the proportion of multiple-unit stock under *B* (6) below increases. A most useful supplementary figure is the number of locomotives under or awaiting repair, which affects the availability for traffic purposes and helps to show whether maintenance and repairs are being properly integrated with traffic peaks.

B (4) *Number of freight vehicles.* Again, this figure is affected by the number under or awaiting repair. If the average capacity of vehicles in the fleet is being increased, a smaller fleet of vehicles should be expected to deal with an equivalent amount of traffic. Therefore, in conjunction with this is needed:

B (5) *Average booked capacity of freight vehicles.* Both *B* (4) and *B* (5) need dividing between the main types of vehicles, open, covered, steel carrying etc. if they are to be useful to the operator.

B (6) *Number of coaching vehicles.* Owing to quicker turn rounds one should expect that as the proportion of multiple-unit vehicles increases, a reduced fleet of coaches can perform an equal amount of work. One must take into account:

B (7) *Seating capacity of coaching vehicles.* By increasing this it should be possible to do the same amount of work with less vehicles.

B (8) *Train engine hours.* The effort expended in doing a given amount of work relates to the mileage performed by the rolling stock as well as to the number of vehicles employed. This is particularly important with motive power as the cost of it depends on the mileage performed to a considerable degree. As a locomotive in traffic is manned and as it may be consuming fuel whether actually moving or not, some information is also needed of activity per engine hour. Train engine hours are based on the time engines are occupied working trains,

including the time trains stand at signals, intervals between trains and time occupied in running light between the motive power depot and the traffic depot—where the distance is under half a mile.

B (9) *Train miles.* In the short term there is more scope for reducing freight train mileage, when traffic declines, than passenger-train mileage, as the timetable commitment must be maintained with the latter. However, even with freight traffic if a good standard of service is maintained, derivatives from the train-mile figures will almost certainly deteriorate when traffic decreases and improve when traffic increases. To maintain scheduled transits a train must run whether there are 25 or 45 wagons to be conveyed and whether they contain average loads of 3 or 10 tons. Separate figures should be compiled for loaded and empty train miles. Avoid drawing unduly optimistic conclusions from these as a freight train having one loaded vehicle or more attached to it for any part of the trip is normally treated as a loaded train for the whole trip, although it may be primarily an empties train.

B (10) *Wagon miles.* Loaded wagon miles are analysed according to the traffic conveyed; i.e., merchandise, coal etc., not the type of wagon. Each vehicle is counted as one, irrespective of its capacity and only the distance worked on trains is counted; shunting is thus excluded.

(*C*) *To Measure Efficiency.*

C (1) *Train miles per train engine hour.* This is a most useful guide to the operator, which is calculated by dividing the train miles (*B*.9) by the train engine hours (*B*.8). It shows the extent to which locomotives are kept moving and also reflects the speed of train movement. Thus it reveals whether the first two principles of operation are being applied as far as motive power is concerned. Guarded use must be made of the figures in comparing steam, electric and diesel. Where there is a similar interval between completing one journey and commencing the next, a steam locomotive might be sent to the depot for water, fire cleaning, coal, etc., whereas diesel and electric locomotives would be retained in traffic sidings. Therefore, the operator would receive a debit for this time with electric and diesel but the time the steam engine was in the shed would not be counted as train engine hours. Comparisons between different areas should be drawn with caution as the figures are affected by gradients and the density of train service. These statistics do not reflect the size of the trains hauled, which is illustrated on the freight side by another figure:

C (2) *Wagon miles per train engine hour.* The total wagon miles divided by the train engine hours reveal the extent to which trains have been loaded to their capacity as well as the mobility of locomotives and the train speeds which have been achieved. In comparing two

periods of time it should be borne in mind that the average capacity of the wagons may have varied.

C (3) *Net ton miles per train engine hour* takes into account the loading per wagon as well as the train loads and the other factors mentioned in *C* (1) and *C* (2). It is a useful guide to over-all performance but is affected by so many different factors that its usefulness is limited. An improvement in one aspect may disguise a deterioration in another, which should be brought to the operator's notice. For example, an increase in train speeds might conceal a deterioration in the loading per wagon or in the number of wagons per train.

C (4) *Unproductive time of train crews.* Separate figures are prepared for drivers, motormen and guards. It is useful for the operator to be provided with statistics showing how much of the time of train crews is being employed productively and how much is being taken up with unproductive activities, such as waiting to relieve other train crews, travelling as passengers, etc. The normal method of expressing this is the percentage of the total hours on duty which is taken up by these unproductive activities.

As with all other statistics they must be used with care. As long as a member of a train crew is working a train his time is treated as productive, even if the train is not moving; e.g. standing at a signal. Therefore, improved figures could result from increased detention at signals. On the other hand if a train crew who had previously worked the outward portion of their diagram in four hours were enabled to work it in three, and the remainder of the diagram was unchanged, unproductive time would be increased. This does not indicate reduced efficiency in working, but does reveal there is increased availability of the crews' time for other work brought about by acceleration.

C (5) *Wagons detached in marshalling yards: (a) per engine shunting hour employed; (b) per man hour.* These statistics have only a limited use. They cannot usually be employed to compare the efficiency of one yard with another as the use of shunting engines depends to a large degree on the type and lay-out of the yard concerned. By its nature a gravity yard may be worked without any shunting engine, a hump yard requires some motive power to propel vehicles to the hump, whereas a flat yard requires more owing to the need to reverse after each shunt. They are more useful for comparing one period with another at one yard, although an improvement may still represent a poor performance in comparison with one that was worse.

The number of wagons detached per hour on duty of the shunting staff naturally varies with the type of equipment employed. For example, the statistics for a yard provided with fully automatic retarding

equipment should be considerably better than for one in which retarding is done by brakesmen. Therefore a more satisfactory figure is one which gives the total cost per wagon detached, which takes into account the cost of wages, track, signalling, shunting engines and all equipment.

C (6). (*a*) *Man hours per ton handled* (*Freight Terminals*); (*b*) *Handling cost per ton for staff wages* (*Freight Terminals*). For checking the efficiency of freight terminals the most common measures applied are those quoted above. They are not entirely satisfactory as they do not take into account the cost of the various types of equipment employed. In consequence, they cannot usually be employed for comparing depots, and must be used cautiously for comparing one period with another.

A more satisfactory figure from some aspects is one which also takes into account: the provision and running costs of goods-handling equipment; the cost of buildings, track, heating, etc.; shunting costs. If these are added, a much higher cost per ton will be given. This figure will represent a better measure of the cost of the depot, but the hours per ton figure is the more useful for comparing staff performances.

C (7) *Terminal discharge time of freight rolling stock.* An important feature in the utilization of freight rolling stock is the speed at which inwards loaded wagons are discharged and made available for reloading. The total number of inwards loaded wagons on hand is divided by the number discharged. The daily figures are totalled and the calculations made on a weekly basis. If the resultant figure is high, some speeding up of the unloading of wagons should be sought.

C (8) *Terminal user time of freight rolling stock.* Terminal discharge time is only a measure of efficiency in unloading wagons. There are other aspects of station working which influence the turn-round of stock, namely: delay in transfer from place of unloading to place of loading; speed of loading; how quickly wagons are despatched after loading. These are taken into account by Terminal User Time figures. These are calculated by dividing the total wagons on hand (loaded and empty) by the total wagons forwarded (loaded and empty). The daily figures are totalled and calculations made on a weekly basis. The smaller the figure, the better the wagons are being turned round.

C (9) *Average round-trip time of freight rolling stock* indicates how many days are occupied on average between each loaded trip. It is calculated by deducting the number of wagons under repairs from the total book stock. The figure of sound wagons available is then multiplied by the number of days in the period concerned, which represents the number of wagon days available. This is divided by the total number of loaded wagons actually forwarded during the period. The answer is the average round trip time expressed in days. At times of

low demand for freight wagons, a number may be out of use. As they are available for use they will be included in the figures and will worsen the statistics for the fleet as a whole.

C (10) *Operating Ratio.* The most important figure for a railway is its operating ratio. To obtain this, the total working expenses are divided by total traffic receipts and multiplied by 100 to give a percentage of receipts absorbed by working expenses.

EXAMPLE. Traffic receipts £500 million
Working expenses £450 million
Operating ratio = 450/500 × 100 = 90.

The operating ratio for an entire railway is made up of the operating ratios for each activity it pursues. Therefore, it is important that operating ratios should be available for individual traffics, individual lines and individual trains.

C (11) *Movement Cost Ratio.* As operating ratios are often difficult to assess on account of the complications arising in apportioning track, signalling and terminal costs between various activities, the operator may find a movement cost ratio useful in estimating the relative profitability of his various activities. This is achieved by dividing the total working expenses by movement costs (i.e., cost of rolling stock, fuel, crew, etc.) by total traffic receipts. Multiply by 100 to give the percentage of receipts absorbed by movement costs.

EXAMPLE. Proportion of receipts from freight on a train which are attributable to that portion of the journey ... £800
Movement costs £400
Movement cost ratio 400/800 × 100 = 50.

One must look for much lower movement cost ratios than operating ratios as the costs for track, terminals, etc. have still to be met.

STATISTICS REFLECTING THE QUALITY OF SERVICE

Up to now the statistics to measure efficiency have all been related to the cost (in man hours, engine hours or in money) of doing a specified amount of work. Statistics which reflect the quality of service given to the customer are also required. One example is as follows.

C (12) *Passenger train punctuality.* Separate statistics are normally compiled for express trains and other trains, and for locomotive hauled, electric and diesel multiple-unit trains. The results may be expressed in various forms which include: (*a*) *Percentage of trains right time*, percentage 1 to 5 minutes late, percentage over 30 minutes late, etc.; (*b*) *Average minutes late.* This reflects the extent of delays more accurately than (*a*). (*c*) *Minutes lost per hundred train miles.*

Neither (*a*) nor (*b*) can be used to compare one area with another as they do not make allowances for the varying distances travelled by the trains concerned. Allowance can be made for this by calculating the average minutes lost per hundred train miles. Comparisons should be drawn with caution on these figures as the operating circumstances of two areas may be completely different in weather, in train density, in track facilities, etc. Similar figures for freight trains should separate express freight and other freight trains.

C (13) *Transit statistics.* These are normally expressed as the percentage of consignments reaching destination on first day after despatch, second day etc. They do not show at what time the consignment reaches its destination, only on which day, and therefore statistics which are apparently satisfactory may conceal an unsatisfactory standard of service. Separate figures are compiled for passenger-rated traffic, for sundries loaded direct to destination, for sundries transhipped *en route*, for full-load merchandise and for minerals.

(*D*) *To Show Trends.*

In his efficiency statistics the ambitious operator will be looking for a constant improvement over the years. Minor set-backs are likely but with improved technical equipment at his disposal, and scientific application of sound principles, work study and other similar techniques the trends should be towards increased productivity and better standards of service. He also needs information on future trends both inside and outside the industry, e.g., the level of production in the industries served, for planning purposes. The building programme for rolling stock, for example, must be based on estimates of future traffic.

CONTINUOUS OR OCCASIONAL STATISTICS

Many of the statistics mentioned previously are compiled on a continuous basis; for example:

A (1) *Passenger journeys originating.*

A (4) *Freight train traffic originating.*

B (8) *Train engine hours* compiled from drivers' and motormen's tickets, which are a record of work performed by all locomotives. From these tickets also is extracted details of train miles.

C (2) *Wagon miles* are based on the record of train loadings made by goods guards; these are called guards' journals.

On the other hand others are compiled on an occasional basis; e.g.:

C (4) *Unproductive time of train crews.*

The enginemen's tickets are compiled on a regular basis, but the unproductive time of drivers may be extracted once a month, once a quarter or at any other suitable intervals, either regular or irregular.

The same applies to the calculation of unproductive time of guards.

C (11) *Movement cost ratios* for passenger trains may be based on the periodical passenger census. For freight trains they may be calculated from traffic details chosen on random dates.

C (13) *Transit statistics* are compiled from the information revealed by transit tests which are held at suitable intervals. Some are done on a continuous basis, others on an occasional basis.

The continuous method has certain merits but is obviously much more expensive to pursue. The occasional method is much cheaper and enables the staff employed to investigate a greater number of matters. It is important that the operator does not receive too many statistics, otherwise he will be unable to make a thorough investigation into them. The statistics should be reviewed periodically to see if any compiled continuously can be reduced to an occasional basis.

Sampling. A moderately large number of items chosen at random from a very large group are almost certain on average to have the same characteristics as the larger group. Therefore, useful statistics can be compiled by taking samples instead of a complete record of a particular activity. This cuts the cost of taking records, and correlating them, and should be used where possible. This technique is often used in connection with *C* (13) Transit statistics.

CARE IN HANDLING STATISTICS

In compiling statistics great care must be used. Make sure that: (*a*) the statistics give accurate complete information; (*b*) the facts given are truly representative as a whole; (*c*) the factors have been very carefully verified and checked; (*d*) all data are pertinent; (*e*) all data conform to the definitions which have been laid down; (*f*) all unusual items are investigated. Also ensure that: (*g*) any statistics which are being compared are, in fact, strictly comparable. Comparisons are often hampered by differences arising from the calendar. The disturbing effects of the changing Easter and Whitsun holidays are an example. See that (*h*) all statistics are compared with an open mind; (*i*) the result is not rejected simply because it is unexpected; (*j*) monetary values, which are constantly changing, are checked by their basic worth; (*k*) when comparing two periods of time, the circumstances have not changed in the interim.

To permit the best use to be made of statistics they should be available as early as possible after the period to which they relate. Statistics are only of use to the operator if he is able to take some action or make a decision on the basis of the information they contain. If he is inundated with a mass of detail which he is unable to use for positive

action, then he is being hindered by the statistics. In this case the expense and effort of compiling them is wasted. In order that they may be of use it is important that they should separate those factors due to economic fluctuations and those within control of the operator.

Statistics are often most valuable when they represent activity on a small scale rather than when they cover the activities of a whole region or the whole railway. When they represent a great mass of activity the good features may tend to cancel out the bad. It is therefore the results for a particular line or a particular train which are most likely to indicate the type of action required. It is during the compilation of statistics that opportunities are indicated showing how improvements might be sought. These are likely to be missed if the work of compilation is delegated to persons who have no interest in, or responsibility for, the operating work concerned. All statistics in use should be re-examined periodically to assess their value in improving operating efficiency. If they are not an effective tool of management and are also non-statutory they should be abolished.

Similarly, regular thought should be given to the desirability of introducing new statistics which will help to secure improved operating efficiency. New techniques in costing and the availability of electronic computers or other similar equipment make it possible for the operator to have more information more quickly than he could hitherto, to help him to run his services more cheaply and to give a better service.

Finally, it is necessary to emphasize again that statistics (with the possible exception of the Operating Ratio) are not an end in themselves. It is not difficult to improve statistics, which measure the costs of operation, by giving traffic an inferior service. Because these statistics only measure efficiency in a limited field, an improvement in them does not necessarily mean any real saving. But a poorer service is likely to lead to a loss in traffic and a worse economic situation.

SUMMARY

1. *Statistics are an essential tool of the operator.*
2. *They must be used cautiously.*
3. *Statistical facts should be carefully collected, verified and checked.*
4. *Continuous statistics should be employed only where occasional statistics are not satisfactory.*
5. *Be cautious in comparing different areas or different periods of time, and take all relevant factors into account.*
6. *Statistics are useful only if action or decision is taken on them.*
7. *Simple statistics on a small scale are often the best guide to action.*
8. *They are a means to an end, not an end in themselves.*

CHAPTER 16

The Pattern of the Future

A DESIRABLE pattern which has emerged from previous chapters may be summarized thus: Good track and effective signalling is the only foundation on which an efficient railway system can be built. They are expensive items and bear particularly heavily on those lines which are used by few trains. It may be better for traffic on lightly used lines to be diverted to other lines or conveyed by road into railheads. This may mean the total loss of some traffic but providing there is an improvement in net revenue over-all, this is still the correct policy.

The best use of line capacity is made by grouping trains of equal speeds. Therefore freight and passenger trains should be segregated where possible either by routes or by time. Segregation by route is less complicated than segregation by time, which entails the bulk of freight work being done at night. This is consistent, however, with what has been written under Freight Traffic Transits regarding the importance of overnight transits, which are the minimum requirement of many traders. The punctuality of passenger trains would certainly benefit from such segregation as much delay results from drivers exceeding their point-to-point running times (this is particularly prevalent on freight trains) and from incorrect regulation by signalmen. It would also benefit freight-train services as the need for them to be brought to a stand while being by-passed by passenger trains would be reduced and therefore the cost of working them would fall. Passenger train services could be improved in frequency by reducing freight movement during the day. It is frequency combined with speed and punctuality that is most likely to maintain and increase traffic in the face of the growth in competition from private transport and air-lines. Really high speeds can be achieved only by having few stops and therefore the number of passenger stations must be reduced so that passenger trains run at high speeds between the main centres of population. This will reduce station costs and train-movement costs. Fast passenger trains are the most profitable activity in the passenger-train group. Many suburban services can probably be made to pay their way by increasing fares to economic levels and by keeping costs to a minimum.

In attempting to segregate passenger and freight trains on a time basis, the main problem arises in the evening when there is a conflict

between the needs of freight, much of which must get on the move if it is to reach its destination next morning, and the needs of passengers. Although passenger traffic is beginning to decline in the evenings, there is still some demand. This confliction can best be dealt with by planning freight-traffic transits from the time the traffic is required at destination and working backwards so that it may leave the sending point as late as possible. By this means certain freight trains may be put back until most of the evening passenger services have finished. In other cases where the use of common track is definitely required for freight purposes in the evening, freight seems to merit a higher priority than it has sometimes enjoyed in the past. This is justified because overnight transits are essential to gain more general merchandise to rail and also to reduce freight working costs particularly by permitting reductions in freight rolling stock. In any case, because the passenger traffic is beginning to fall off at this time of day, the profitability of the services is not likely to be as good as the potential profitability of freight traffic dealt with on an overnight basis.

In certain cases the confliction in the evening may best be resolved by limiting the number of passenger trains and by dropping their speed to the speed of the freight services with which the track is being shared. This will reduce by-passing and all the delay which results from it. Sleeping-car services which also require to share the track with freight services in the night should perhaps in certain cases also run at the same speed as the express freight trains so that all traffic may be kept on the move. This pattern of most freight by night and most passengers by day, emphasizes the importance of having a large percentage of the motive-power fleet as mixed-traffic locomotives. These may then be kept in use for as long as their availability permits. Increased availability of electric and diesel locomotives, as compared with steam locomotives, is of no value unless it is put to use for traffic working.

Overnight transits will not result from merely giving freight trains greater priority during the evening and night hours. They can only come about in certain instances by the concentration of traffic at fewer freight terminals to permit more through trains. Concentration at fewer points should enable a greater degree of mechanization to be introduced thus reducing costs. The terminals should be geared to deal with all traffic currently. This concentration is likely to lead to increased cartage costs but these should be more than off-set by reduced terminal costs and much lower train working expenses. Concentration of freight traffic should permit a reduction to be made in the number of marshalling yards but some will still be required. These

should be adequate to deal with the peaks which necessarily arise on a railway committed to a quick-transit policy. As overnight transits are developed, some yards should not be required to be open during parts of the day.

The number of coaching rolling stock vehicles should be reduced and the smaller fleet used more intensively. Fast speeds and quick turn-rounds are effective methods of achieving this. Rapid turn-rounds are facilitated by the use of multiple-unit stock, but because of the unavoidable inactivity of most coaching stock at night time, their introduction must be restricted in order that mixed-traffic locomotives may be kept employed both during the night and throughout the day.

All these things can be achieved only by a comprehensive and realistic plan of operation, which must be adhered to by all concerned and only modified when an efficient Control is quite satisfied that some alteration is desirable. Better planning and a determination to stick to the plan should reduce the amount of improvisation which Control offices make. This reduction in Control work should permit the Controllers to play a greater part in securing reliable transits. Finally it has been shown that to plan intelligently and to supervise effectively Operating Statistics are necessary.

RATIONALIZATION

Great emphasis has been laid throughout on the importance of shedding those activities, such as stopping and branch-line services, which lose money and therefore detract from the profitability of the system as a whole. It can be argued that a nationalized industry has a duty to provide certain services which are not profitable. If this is so, it cannot be reconciled with the need for the industry to balance its books, as in the vigorous competitive field of transport other traffics cannot be called upon to subsidize the unprofitable ones. Therefore, the operator must clearly identify those activities which are uneconomical, and cannot be made economical, and must withdraw them or apply for permission to withdraw them where necessary.

Unless the operator takes this action there is a danger that he will lose traffic which is ideally suited for rail transport, because it is required to bear too high a rate in order to support the uneconomic activities. As more and more profitable traffics are lost in this way, the over-all position will become progressively worse. If uneconomic services are pruned there is no doubt that the railway system can be profitable, and can provide an efficient service by concentrating on those activities for which it is most suitable under present day conditions.

OPERATING STAFF

Comparatively little mention has been made in previous chapters about the staff who do the operating work. This has been quite deliberate as the subject of operating staff is worthy of a separate book. But let us be quite clear about this. None of the improvements in service or reductions in cost which have been enumerated can be achieved without the active co-operation of the staff who man the trains, the signal-boxes, the stations and so on.

In Chapter 1, for convenience, they were referred to as units of operation. This was done only to simplify the text. They are not units, and a good operating manager will never make the mistake of treating them as units. Each one is an individual being who merits individual and considerate treatment. Their co-operation in improving efficiency will be forthcoming if they are properly consulted and treated. There is no doubt about this as it is in their interest, above all, that there should be an efficient railway system which is economically viable. Their rewards and their jobs, must in the long term depend on this.

There is of course a need to employ staff of a good quality, and to relate earnings to effort so that industry and good work receive proper recognition. Once it is apparent that what one gets out of one's employment depends on what one puts into it, the operating results are likely to improve.

Finally, there is the need for first-class supervision and management. Where this is inadequate it is often unwise to increase the number of supervisors and managers. An improvement in quality rather than in quantity is likely to give better results.

With all staff, whether supervisor or supervised, there is a need for education and training. This is necessary so that each may see how his contribution fits into the pattern as a whole and so that all may know what is the objective and how it can best be secured. It is hoped that this book may play a small part towards that end.

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RAILWAY OPERATING PRACTICE

Operating Principles: Track and Signalling: Freight and Coaching Stock: Motive Power: Stations, Terminals, Marshalling Yards: Plan of Operation: Control Office: Services and Transits: Punctuality: Statistics

FOREWORD by A. R. DUNBAR, O.B.E.